JOURNAL

OF THE

AMERICAN WATER WORKS ASSOCIATION

VOL. 27 JUNE, 1935 No. 6

CONTENTS

The New Water Purification Works at Burnt Mills, Maryland. By Robert B. Morse..... 679

Design of Water Purification Plants at the South End of Lake Michigan. By Paul Hansen..... 692

Customer Inquiry Procedure. By John A. Bruhn..... 703

Indiana Rainfall and What is Ahead. By J. H. Armington. 710

Disaster Preparedness. By Burt Harmon..... 719

The Emergency Treatment of Water Supplies Following Major Catastrophes. By R. F. Goudey..... 723

Laying Water Mains in Rock Formation. By F. G. Browne..... 730

Flushing of Water Mains. By C. E. Brown..... 735

Flushing of Water Mains. By C. G. R. Armstrong..... 739

Synura Troubles at Albany, N. Y. By George E. Willcomb..... 742

Low Water Troubles at Quincy, Illinois. By W. R. Gelston..... 749

Legal Aspects of a Large Artificial Lake Water Supply Project. By Clayton J. Barber..... 755

Water Works Records and Their Significance. By George B. Prindle..... 761

Report of A-21, Sectional Committee on Specifications for Cast Iron Pipe and Special Castings, Year 1934..... 767

Discussion. Spectrographic Determination of Minor Chemical Constituents in Water Supply. By E. S. Hopkins..... 772

List of Section Papers. Florida, Southeastern, Illinois, Montana, Pacific Northwest..... 775

Abstracts..... 778

All correspondence relating to the publication of papers should be addressed to the editor, Abel Wolman, 2411 North Charles Street, Baltimore, Maryland.

Because of the necessity for rigid economy, no reprints of articles will be furnished to contributors free of charge. Reprints may be purchased at the usual prices.

• • FAMOUS VICTIMS OF WATER BORNE DISEASES

LOST TO THE CAUSE OF HUMANITY —LOUIS THUILLIER, SCIENTIST

STRANGE irony of fate that Pasteur, founder of modern preventative medicine, should lose not only his brilliant assistant, Thuillier, through death from cholera...but...in addition, two of his cherished daughters from typhoid fever—both water-borne diseases.

Chlorination of drinking water—the protection that even Pasteur's brilliant discoveries had not disclosed—is today available to all.

W & T Visible Vacuum chlorinators with their acknowledged dependability, with their low maintenance cost and simplicity of operation, make it possible to secure this prevention of water-borne disease transmission at a cost of less than one penny per person per year. That is an achievement of modern science and invention.

We urge you to think seriously of our slogan, "The Only Safe Water is a Sterilized Water."

Technical Publications 38, 157 and 158 describe W&T Visible Vacuum chlorinators in detail. A copy of one, or all, is yours for the asking.

WALLACE & TIERNAN CO., Inc.

Manufacturers of Chlorine and Ammonia Control Apparatus

NEWARK, NEW JERSEY Branches in Principal Cities...Main Factory, Belleville, N. J.

BA-61

JOURNAL
OF THE
AMERICAN WATER WORKS ASSOCIATION

The Association is not responsible, as a body, for the facts and opinions advanced in any of the papers or discussions published in its proceedings
Discussion of all papers is invited

Vol. 27 JUNE, 1935 No. 6

THE NEW WATER PURIFICATION WORKS AT BURNT MILLS, MARYLAND

By Robert B. Morse

(Chief Engineer, Washington Suburban Sanitary District, Hyattsville, Md.)

At Burnt Mills, Maryland, the Washington Suburban Sanitary District, an area of approximately 104 square miles in Maryland adjoining the District of Columbia, has under construction water purification works and pumping stations which present a number of novel or at least unusual features.

These purification works, which will have a rated capacity of 10 million gallons per 24 hours, serve an area now containing a population of 75,000 and having 325 miles of water mains. They supersede a smaller plant erected in 1923 and intended as a temporary installation.

The new works will include aerators; preliminary sedimentation reservoir; head house and raw water pumping station; two assemblies each containing a coagulating basin, four filters, filter control house, pipe vault, and filtered water reservoir; a high service pumping station in which there are also chemical machines and a laboratory; a small hydro pumping plant, and a high tension sub-station.

Work on the high service pumping station is nearing completion. One 5 Mgd filter assembly, with its coagulating basin and filtered water reservoir, was placed in operation early in May, 1934, being

fed by gravity until the raw water pumping plant was started in December. The hydro station has operated almost continuously since November. The foundation and much of the piping for the second 5 M̄gd filter assembly have been completed and it is likely that the remaining work will proceed this year.

Owing to the restricted area available, topographical features, and division of the site into two almost equal parts by a main highway, the layout of the plant considered as a whole was not as compact as otherwise would have been possible. Pumping machinery, chemical machines, and chemical storage had to be located in two

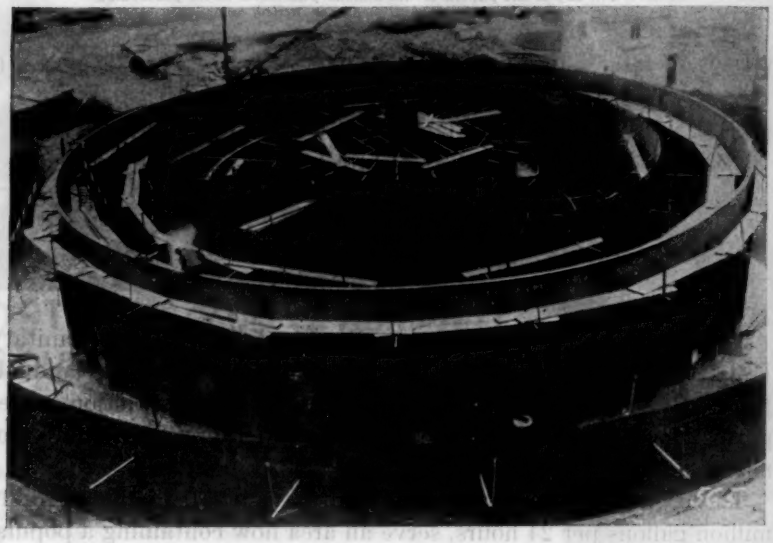


FIG. 1. STEEL WORK UNDER ERECTION

main buildings, one on each side of the highway, and it was impossible to place preliminary sedimentation reservoir, coagulating basin, filters, and filtered water reservoir in a single 10 M̄gd assembly, which would have been most economical and entirely practicable on a commodious and level site.

Northwest Branch, with a drainage area of 27 square miles at Burnt Mills, is impounded in a small reservoir formed by an Ambursen dam 215 feet long on top, with spillway about 22 feet above original water level in the stream. A 42-inch cast iron pipe delivers water to aerators through a 30-inch branch, and to a hydraulic tur-

bine through a 36-inch branch. From the aerators water passes through the preliminary sedimentation reservoir and thence to the raw water pumps which raise it to the coagulating basins, whence it follows the usual course through filters, filtered water reservoirs, and to high service pumps.

The water to be treated presents highly variable characteristics as to turbidity. For weeks it may run as low as 10, sometimes even 5 p.p.m., then rise to 500 or more within a short time. Occasionally it reaches 1000 and rarely 5000. The highest turbidity since the stream was first used in 1924 has been 12000 p.p.m., in June, 1934. At that time the turbidity rose from 30 to 5000 within 40 minutes. Turbidities generally fall rapidly except in summer when they may remain at comparatively high levels for a considerable time.

AERATORS

Aerators are of the Aer-O-Mix type, two in number, each of 6 M̄gd rating. Blowers are provided so that additional air may be applied to the U-tubes of the Aer-O-Mix machines when the flow of water is too small, or its head too low, for these machines to give effective aeration otherwise. Piping is so arranged that either the aerators or the preliminary sedimentation reservoir, or both, may be by-passed.

PRELIMINARY SEDIMENTATION RESERVOIR

The preliminary sedimentation reservoir is a rectangular reinforced concrete structure, 200 feet by 110 feet in plan, with water depths of 8.5 and 6.0 feet at the inlet and outlet ends, respectively, and as great as 13.0 feet near the center. Its capacity is such as to give a nominal sedimentation period of four hours at a 10 M̄gd flow, without allowance for space occupied by sludge. This reservoir was built in a decidedly unfavorable location, requiring at some points much rock excavation and at others the substitution of lean concrete fill for unstable earth removed.

PUMPING STATIONS

The raw water and high service pumping stations are steel-framed brick buildings with roof of nailing concrete and slate. In the first-named building six motor-driven centrifugal pumps, with a total capacity of somewhat more than 20 M̄gd against a head of 12 feet, raise the water from the preliminary sedimentation reservoir to the coagulating basins on the opposite side of the highway. The

two largest, of 5 M̄gd each, have auxiliary gasoline engine drive. The two smallest, of 2 M̄gd each, are automatically controlled from the water level in the coagulating basins. Their discharge lines are equipped with Roto-valves instead of gate and check valves. A 16-inch Rotovalve on the 30-inch inlet line to the aerators automatically maintains a constant water level in the preliminary sedimentation reservoir which connects directly with the suction wells supplying the raw water pumps.

CHEMICALS

On the second floor of the raw water pumping station four dry-feed chemical machines apply alum, soda ash (when necessary), and activated carbon to the water. The last-named is normally fed into the water just before being pumped to the coagulating basins, while alum and soda ash may be applied either at the same point or just before the water passes to the aerators on its way to the preliminary sedimentation reservoir, or they may be fed at both locations at the same time. Chemical storage space is provided on the second and third floors.

Seven electrically operated centrifugal pumping units (one of them not to be installed at present), with a combined capacity of over 19 M̄gd at a head of 275 feet, comprise the pumping equipment in the high service station. Two of the largest pumps have 240 HP gasoline engines as auxiliary prime movers. All of the pumps take suction from a 24-inch header which will interconnect the two filtered water reservoirs. All except the smallest pump have Rotovalves on their discharge lines. The switchboard is housed in a separate room.

Above the high service pump room a chemical machine room, laboratory, and office are located, and above these a floor for storage of chemicals. A compartment, separated from the chemical machine room, contains liquid chlorine and ammonia apparatus. The equipment in the machine room consists of three dry feeders, one for applying lime to the filter effluent, another for use with alum when water is diverted by gravity from the main supply line, as it can be when the reservoir is full and the raw water of low turbidity, and the third for activated carbon whenever it proves desirable to feed this material directly onto the filters. In the machine room, also, are indicating rate-of-flow gauges and sight glasses for each of the eight filters.

Except in the chemical storage rooms the floors in the raw water

and high service pumping stations are finished in "Euboeolith" cement, colored green. All partitions are of rock lumber. Owing to the fact that the period of maximum demand falls in the summer and that with a slightly increased load current for heating will cost only one-half cent per KWH, all buildings are heated by electricity under thermostatic control. Consequently furnace rooms, furnaces, and chimneys are not to be found. In order to secure effective insulation, and at the same time a pleasing finish and a deadening of sound, the walls and ceilings in the raw water and high service pumping stations, except in the chemical storage rooms, have been lined with "Cork-

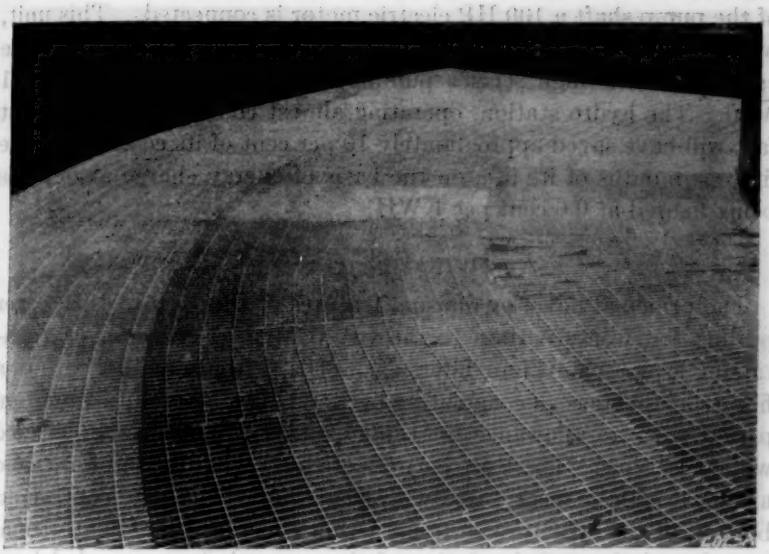


FIG. 2. TRI-LOK GRATING IN THE FILTER CHAMBER

oustic," 1½ inches thick. Buff-colored walls and ivory ceilings composed of this material, in conjunction with the green floors and the pumping machinery painted in light gray, present a decidedly attractive appearance, and insulation is so effective that necessary wattages per cubic foot of space are much less than the figures ordinarily used for the temperature rises required.

HYDRO PLANT

During a considerable part of normal years Northwest Branch yields more water than will be used in the filtration process. With-

out a large additional expenditure it was possible to construct a small hydro plant which provides a valuable auxiliary or emergency source of pumping, keeping down the maximum demand charge during on-peak hours in the winter when the stream-flow is ordinarily above normal, and reducing the required gasoline engine capacity, not to mention the incidental saving obtainable in a decrease of electrical energy used. This plant is equipped with a turbine, rated at 105 HP and 120 HP at 33 and 37-foot heads, respectively, direct-connected through speed-increasing gears to a centrifugal pump having a capacity of 1.75 M̄gd against a head of 275 feet. To the other end of the pump shaft a 100 HP electric motor is connected. This unit, pumping filtered water into the distribution system, increases the capacity of the high service pumping equipment to a total of 21 M̄gd. The hydro station, operating almost continuously since last fall, will have saved approximately 10 per cent of its cost during the first six months of its use, on the basis of energy charge alone, this being figured at 0.6 cent per KWH.

FILTRATION PLANT

The principal novel or unusual features of the Burnt Mills water purification works pertain to the two 5 M̄gd assemblies both containing a pipe vault, four filters each of 1.25 M̄gd nominal rating, a filter-control house, a coagulating basin giving a 55-minute detention period with no allowance for sludge, and a 275,000 gallon filtered water reservoir. These are entirely of steel, cylindrical in form, and arranged concentrically, one within another. The flat, continuous bottom of the structure rests on a thin concrete base, lightly reinforced, and the outisde plating of the reservoir is surrounded by a loose rock collar to a height of four feet, beyond which there is earth fill.

All compartments have been designed against crushing when empty, with surrounding chambers full. All seams are welded, those between the coagulating basin and the filtered water reservoir having a continuous weld on both sides, so as to eliminate all possibility of slight leakage. Excepting the roof of the filtered water reservoir, which has a thickness of $\frac{3}{16}$-inch, all plating is $\frac{5}{16}$-inch thick.

A cylinder, 24 feet 6 inches in diameter, in the center of the assembly, contains the operating piping, hydraulic valves, and a small, automatically-operated centrifugal pumping unit for filling the wash water tanks from the filtered water reservoir. Above the pipe

vault a steel house, of 20-foot diameter, contains Williamson "Selecto-Valve" stands for operating all hydraulic valves controlling filter action, recording rate-of-flow gauges, and at the center a glass-covered steel stack rising out of the pipe vault and into which the filter effluent lines discharge, allowing the slightest turbidity to be detected immediately. The control house has a "Euboeolith" floor laid over steel plating, is heated by electricity, and is insulated against heat and cold by means of cork-board, 2 inches thick, on the sides, and by a ceiling of the same material.

FIG. 3. FILTER CONTROL HOUSE

Outside of the pipe vault, and placed concentrically therewith, a steel ring of 54 feet 3 inches diameter forms the outside of the filter compartments. The space between this cylinder and the pipe vault cylinder is divided into four filter units by vertical, radial bulkheads. Radial steel wash water troughs, topped by a cypress strip which is planed so as to insure even distribution of wash water, discharge into a steel downtake and thence to a drain leading into the pipe vault where the controlling valve is located. Upon a steel framework, approximately six feet above the bottom of the filter chamber, rests a flooring of "Tri-Lok" grating placed in radial sections. A bed consisting of 16 inches of graded gravel, 2 inches of

grit, and 24 inches of sand (effective size 0.52 m.m.), lies on this grating which is composed of galvanized copper-bearing steel.

Two separate piping systems collect filtered water from, and supply wash water to, the chamber below the filter bed. Each system has three major openings for the purpose of securing even distribution of flow. Elbows deliver the wash water vertically down towards the bottom of the compartment in order to insure diffusion and prevent violent upward movement. The main wash water pipe entering each filter is connected to a line which encircles the pipe vault and

FIG. 4. FILTER ASSEMBLY AND HIGH SERVICE PUMPING STATION

lies within it. To this ring the feed pump delivers, and from it a main leads to the wash water standpipes on a near-by hill.

Between the cylinder forming the outside of the filters and a 72-foot diameter ring lies the coagulating basin. The flow in this basin passes forward around the outside of the filters and is taken off at a low velocity through an inverted cone located at a point diametrically opposite the inlet.

The outside ring of the coagulating basin forms the inside of the filtered water reservoir, and a cylinder 100 feet in diameter, the extreme outer limit of the steel assembly, provides the outside shell of this reservoir. Beams support the steel roof of the reservoir

which has a height of 10 feet, compared with a height of 14 feet 6 inches for the coagulating basin and filter compartments.

Not only the coagulating basin, but the filters as well, are uncovered. This arrangement saved a large sum in cost of construction and was decided upon as a result of experience in operating, during six winters, two small uncovered steel filter units which had been installed at the temporary Burnt Mills plant with the original intention of meeting increased summer demands only. This test proved that open rapid sand filters may be operated in moderately severe winter climates without difficulty and with only slightly increased expenditure for labor, and that it makes little or no difference whether or not the filters are covered with ice.

OPERATION IN COLD WEATHER

During the past winter the new open filters at Burnt Mills passed through a severe spell of weather, easily meeting every test. Under temperatures as low as −18°F., and with sustained average minima of −14.5°, −5.8°, −2.4°, 1.9°, 6.7°, 14.8°, and 19.7°, for 2, 5, 10, 15, 20, 40, and 90, consecutive days, respectively, no difficulty was experienced in operation and no damage occurred to the steel structure, not even any appreciable scratching of the paint from the effects of ice movement. Ice reach a thickness of 22 inches on the coagulating basin and a maximum of somewhat more than 11 inches before it was removed from the single filter on which it had been allowed to collect. On the exposed sides of the coagulating basin and filtered water reservoir ice gathered on the steel work to a thickness of four inches, but practically none formed on the surface of the water in the filtered water reservoir.

Around the inlet to the coagulating basin the water surface remained clear of ice at all times, and the thickness over the outlet cone having its lip 24 inches below the surface was never enough to interfere with the flow. The rise and fall of the water surface was sufficiently continuous to prevent tight ice adherence to the steel plating, and the constant flow of water in the basin resulted in a mushy ice formation which, although very thick, disappeared much more rapidly with the arrival of moderate weather than did the thinner ice sheets covering the Burnt Mills reservoir and the preliminary sedimentation reservoir.

On three of the filters ice was allowed to form only to such thickness as it would between washing operations. This was at no time

more than 1¼ inches owing to surface movement of the water, and freezing occurred only slightly except at temperatures of 10° or lower. Just previously to washing a filter, unless the ice was so thin that it would break up of its own accord when the water level dropped to the elevation of the wash troughs, the operator or a laborer would break the ice sheet with a pole sufficiently to allow it to pass off to the downtake and thence to the drain during washing. The time consumed by this operation varied from three to ten minutes.

Wherever long-continued periods of sub-zero minimum daily temperature are not of ordinary occurrence, uncovered filters are economical, and it is possible to operate them even under persistently severe conditions with a small additional expenditure for labor and with increased frequency of washing during the worst weather, particularly if washing operations are concentrated in the night hours when temperatures are usually lowest.

OPERATING RESULTS

One 5 M̄gd steel assembly has now been in constant operation for more than eleven months, giving complete satisfaction. During the last six months the filtered water turbidity has averaged 0.1 p.p.m., reaching a maximum of 0.5 p.p.m. on only two occasions, although raw water turbidity has averaged 41 p.p.m., with a maximum of 1500. Color of the filtered water has averaged 0.6 p.p.m., reaching 3 only three times and a maximum of 5 on two occasions, while the raw water has averaged 50 p.p.m. The quantity of wash water used was rather large before the preliminary sedimentation reservoir came into service, on account of experimentation with rates, the short period in the coagulating basin, unusually high prevailing turbidities during the summer of 1934, and the many filter-washing demonstrations given before visitors. Excellent results are now obtained at a rate of 12 gallons per square foot per minute, and with the consistently low turbidity of the effluent from the preliminary sedimentation reservoir the amount of wash water now consumed is low (1.7 per cent in March).

Where a raw water is highly turbid at times yet ordinarily of low turbidity during dry weather, a considerable saving in the consumption of chemicals may be made, and greater stability of plant operation secured, by providing for preliminary sedimentation and the use of a smaller coagulating basin than would be otherwise desirable. When the water is cold and floc formation is slow, coagulating chemicals

may be added at the entrance of the preliminary sedimentation basin; extremely high turbidities may call for a dose at that point and another before the water enters the coagulating basin; and at other times preliminary sedimentation alone will relieve the water of enough of its turbidity to allow a low and relatively even dose of chemical at the entrance of the coagulating basin. This is the routine at Burnt Mills.

The compact arrangement of the filter assembly and its piping, and the type of filter bottom employed, result in exceedingly small losses of head both during filtering and washing operations. In this design, therefore, either a lower wash water tank or smaller wash water piping than ordinarily provided may be used. Also, a low loss of head in filtration is an item of importance. At Burnt Mills, during a hot week last summer, with the filters running at times more than 20 per cent above normal rate, the loss of head ranged between 4 and 7.2 feet. Water did not fall below a depth of 6.3 feet in the filtered water reservoir and rose to a maximum of 9.5 feet, which is only three inches below the overflow. The bottom of this reservoir is at the same elevation as that of the filter chambers.

CONDITION OF STEEL

No deterioration of the steel work in the plant can be found at the end of the first year of operation. The alum-treated water has no visible effect on the steel in the coagulating basin and filter chambers, nor on the wash water troughs. The only imperfect conditions discerned have been due to improper painting, as follows: a slight showing of bare steel at the upper limit of the bitumastic enamel coating where a small amount of this material was loose, probably due to lack of primer at this point; a slight scoring of some of the paint on the wash water troughs which had received only one coat of paint due to haste in placing the plant in operation; scaling of the paint on galvanized doors and railings, which might better have been ungalvanized; and blistering of the unsuitable white enamel paint which was used on the inside of the filtered water sight well in the control house.

There appears to be no sounder reason to avoid the use of steel in gravity filter plant construction than for pressure filters, standpipes, or elevated tanks. With reasonable painting maintenance the life of a steel assembly of the Burnt Mills type should be practically unlimited, and painting should not be necessary any oftener than in the

case of standpipes, except for wash troughs and for brightening outside surfaces, in order to maintain a continuously high state of presentability. The possibility alone of reproducing the original condition of the surface at any time by painting gives steel a great advantage over reinforced concrete for filter plant construction, as will be evident when one remembers the sad appearance and state of disrepair of many concrete structures connected with water works.

Burnt Mills itself furnishes striking evidence of the durability of steel for filter plants. For eleven years two 125,000 gallon steel tanks, one serving as a coagulating basin and exposed to alum-treated water and the other as a filtered water reservoir, were half buried in the ground without protection. Inside surfaces were painted initially, and outside surfaces above the ground had received one coat of paint since. These tanks had seen about six years of service previously as coagulating basins before being torn down and re-erected at Burnt Mills. When they were finally removed, to make room for the present works, the steel plates and shapes, even those which had been below ground, were in sufficiently good condition to have served indefinitely at a new location. Again: four smaller steel tanks, new when erected, served for six years as coagulating basin, filters, and filtered water reservoir in an extension of the temporary water purification works at Burnt Mills. These were also partly buried in the ground and received only slightly better painting treatment than the others. The steel was in excellent condition when the tanks were removed. One of these tanks now serves in another location as a ground reservoir in a town water system, while one of the wash water tanks at the new Burnt Mills plant was built out of the steel from the others.

COSTS

From the standpoint of compactness the arrangement of units used at Burnt Mills is all that could be desired. As noted previously this 5 M̄gd assembly occupies a circle exactly 100 feet in diameter. Aside from mere arrangement of the constituent parts, the use of steel is a factor in compactness since practically no area is consumed in wall thickness. Marked economy in cost of construction resulted both from the design of the assembly and the material of which it was built. The steel work erected but unpainted, including the control house complete, cost approximately $25,000, or $5,000 per M̄gd, while the total cost of the assembly, ready to run, including

excavation, foundations, "Tri-Lok" grating, painting, all piping, valves, control stands, rate-of-flow guages, lighting, heating, and filter sand and gravel in place, amounted to approximately $50,000, exclusive of engineering and overhead expense, or $10,000 per M̄gd. Under present conditions the expenditure might reach $65,000 or even $70,000, equivalent to $13,000 or $14,000 per M̄gd.

The total cost of the project, including supply line, pumping stations, preliminary sedimentation reservoir, hydro plant, substation, second 5 M̄gd steel assembly, retaining wall along stream, roads, walks, grading and planting, and lighting of grounds, will be approximately $375,000, or $37,500 per M̄gd, exclusive of engineering and overhead expense.

A steel filtration plant of the Burnt Mills type will not cost, ordinarily, more than from 60 to 75 per cent as much, depending upon capacity, as an equivalent conventional reinforced concrete plant. One using the same arrangement of units, but constructed of reinforced concrete would show a considerable saving over the conventional type, although not as great as if built of steel.

A study of the first year's operating results leads to the opinion that it will be entirely feasible to run the Burnt Mills works continuously at a rate of at least 12.5 M̄gd, for which capacity all piping and other waterways were designed to give low hydraulic losses. Even before the preliminary sedimentation reservoir came into use the filters and coagulating basin exhibited excellent results at 25 per cent above normal rating when raw water turbidities were not unusually high.

All of the construction work at Burnt Mills, except the steel filter assembly, which the Chicago Bridge and Iron Works furnished and erected, and the installation of the steel framework, "Euboeolith" floors, "Corkoustic" insulation, rock lumber partitioning, flashing, weather-stripping, and slate work for the buildings was accomplished by the day labor forces of the Washington Suburban Sanitary Commission.

(Presented before the 4-states Section meeting, April 11, 1935.)

DESIGN OF WATER PURIFICATION PLANTS AT THE SOUTH END OF LAKE MICHIGAN

By Paul Hansen

(Consulting Engineer, Chicago, Ill.)

Two notable reports have been published relative to water supply and sewage disposal at the southerly end of Lake Michigan. One is entitled "Report of an Investigation of the Pollution of Lake Michigan in the Vicinity of South Chicago and the Calumet and Indiana Harbors, 1924–1925" by H. R. Crohurst, Sanitary Engineer, U. S. Public Health Service, and M. V. Veldee, Past Assistant Surgeon, U. S. Public Health Service, in coöperation with the Sanitary District of Chicago, the Chicago Department of Health, the Indiana State Board of Health, and the Illinois State Department of Health. The other is entitled "Report on a Collective Survey of the Efficiency of a Selected Group of Municipal Water Purification Plants Located Along the Great Lakes," by H. W. Streeter, Sanitary Engineer, U. S. Public Health Service, 1926–1927.

Crohurst and Veldee conclude their report with the following words:

> The pollution of Lake Michigan by sanitary sewage and industrial wastes discharged from the Calumet district in Illinois and Indiana, especially from Indiana, is such as to render the sources of water supply now used by Hammond, Whiting, and East Chicago unfit for that purpose, even with elaborate and efficiently operated purification plants.
>
> The source of water supply of Gary, Indiana, though lying outside of the zone of grossest pollution, is also seriously contaminated, but not beyond the capacity of modern purification processes to safeguard it.
>
> The water supplies drawn by the city of Chicago from the Sixty-eighth Street and Dunne cribs are also affected and at times may be seriously endangered by sewage pollution from the Calumet district.
>
> The existing water intakes in Lake Michigan, north of the Dunne and Sixty-eighth Street cribs, appear to be beyond the zone of pollution from the Calumet district and are receiving water of such quality that it can be satisfactorily purified by artificial processes, excepting the supplies of Waukegan and Lake Forest. Although the pollution of these latter supplies is in no way chargeable to the Calumet district, and its discussion is beyond the scope of this report, the existing pollution in this area of the lake, north of the Sanitary District of Chicago, obviously demands attention and abatement.

If the use of the lake as a source of water supply for the urban population in the southern part of the city of Chicago and Calumet district is to be continued, as seems inevitable, it is necessary in the interest of public health that the water supply intakes in this locality be protected. To remove the intakes beyond the zone of at least occasional pollution would require their extension very far into the lake, to a distance which is probably not practicable. Moreover, in the absence of any remedial measures, it is to be anticipated that the present zone of gross pollution would be extended, with the increase in population and development of the adjacent land area, thereby increasing the danger from intermittent contamination of the water from the extended intakes and of the water of other intakes. The obvious remedy for the present extremely unsatisfactory conditions, in the southern end of Lake Michigan, is abatement of the existing pollution from the sewage and industrial wastes reaching the lake directly or through the Calumet River and Indiana Harbor Ship Canal. The choice of methods to achieve this end involves engineering and economic problems which it is not within the province of this report to discuss. There is no question, however, that abatement of the existing pollution is possible, notwithstanding the difficulties which it may present, and it is certain that the need is imperative.

Mr. Streeter in summing up his report on water purification plants along the Great Lakes says in part:

In so far as the foregoing indications may be regarded as being reasonably valid, they would appear, broadly, to signify: (a) That a mean density of B. coli approximately 4,500 per 100 cubic centimeters, as expressed in terms of the B. coli index, represents an upper limit of raw water pollution, beyond which a majority of the Great Lakes plants, *as at present designed and operated*,[1] would be clearly overburdened; (b) that mean densities ranging between 1,000 and 4,500 per 100 cc. represent a doubtful zone within which some plants might be overburdened for a significantly large proportion of the time, and (c) that with mean densities ranging below approximately 1,000 per 100 cc., the majority of such plants would not be expected to be overburdened except for a comparatively small proportion of the time.

In connection with the foregoing conclusions, it should be pointed out that none of the plants of the Great Lakes group surveyed possessed, at the time of the survey, the more highly elaborated features of construction, such as double-stage coagulation-sedimentation, or other auxiliary sedimentation devices which are becoming more commonly used at plants of the same general type treating the more highly polluted river waters in this country. If such features should be installed, or if more liberal sedimentation and filtration capacities should be provided at the Great Lakes plants, it appears possible from the evidence thus far collected in these studies that the permissible raw water B. coli maxima above stated might become increased, to some extent at least, without resulting in any substantial deterioration in the average bacterial quality of the final effluents produced by such plants. . . . .

[1] Italics by the author.

In view of the close relation existing between the sources of pollution of marginal zones of the Great Lakes and the location of water intakes in these zones, it appears very probable that lapses in the efficiency of purification or in the bacterial quality of effluents of water filtration plants located along the Great Lakes may be potentially more dangerous to water consumers than would be similar lapses in the purification of ordinary river waters. . . .

In view of this situation, it is especially desirable that further and more adequate study be given to the questions with which this report has dealt, in order that a more definite basis may be established for striking a proper balance between measures having to do with reducing, where necessary, the pollution of sources of water supply located on the Great Lakes and those concerned with the purification of water derived from such sources. Although in the future as in the past, a large measure of dependence probably will be imposed mainly on water purification, as being the more effective and economical safeguard, the present study has indicated that this measure has definite limitations, which may prove to be the most important single factor involved in the protection of water supplies in this region. A continued effort should be made, therefore, to evaluate these limitations within a sufficiently narrow and definite range to afford a basis for the ultimate formulation of a practical working criterion of permissible pollution of marginal waters of the Great Lakes, which both now and in the future must continue to be the only available source of water supply for one of the most important sections of the country.

Here we have two extensive and competent studies, one approached from the point of view of sewage disposal and the other approached from the point of view of water purification. Both demonstrate that the most heavily polluted area of Lake Michigan, and in fact of the entire Great Lakes, lies between the outlet of the Indiana Harbor Canal and the mouth of the Calumet River. Both affirm positively that the water within this area is too highly polluted to be successfully purified by established methods. Both emphasize that improved sewage disposal must come to the aid of water purification. Both agree that Lake Michigan constitutes the only practicable source of water supply for the cities along the shores at the south end of the lake. The first report points out the impracticability of extending intakes far enough out into the lake to obtain a water sufficiently free of pollution and turbidity to render purification of the water unnecessary. In a paper presented before the Lake Michigan Sanitation Congress in 1926 Hansen[2] estimated that the average daily consumption must be 130,000,000 gallons or more before an intake extending ten miles into the lake would be cheaper than filtration and with an

[2] Proceedings of the Lake Michigan Sanitation Congress, Vol. III, No. 3, July, 1927.

intake extending one mile into the lake. It is not certain, however, that water of satisfactory quality can be obtained 10 miles from shore. A wind drift in October, 1932, indicated clearly that taste producing wastes from Whiting and Indiana Harbor traveled as far north as Highland Park and necessitated heroic measures at the various north shore purification plants to remove the taste. Danger of occasional pollution from passing boats is also always present.

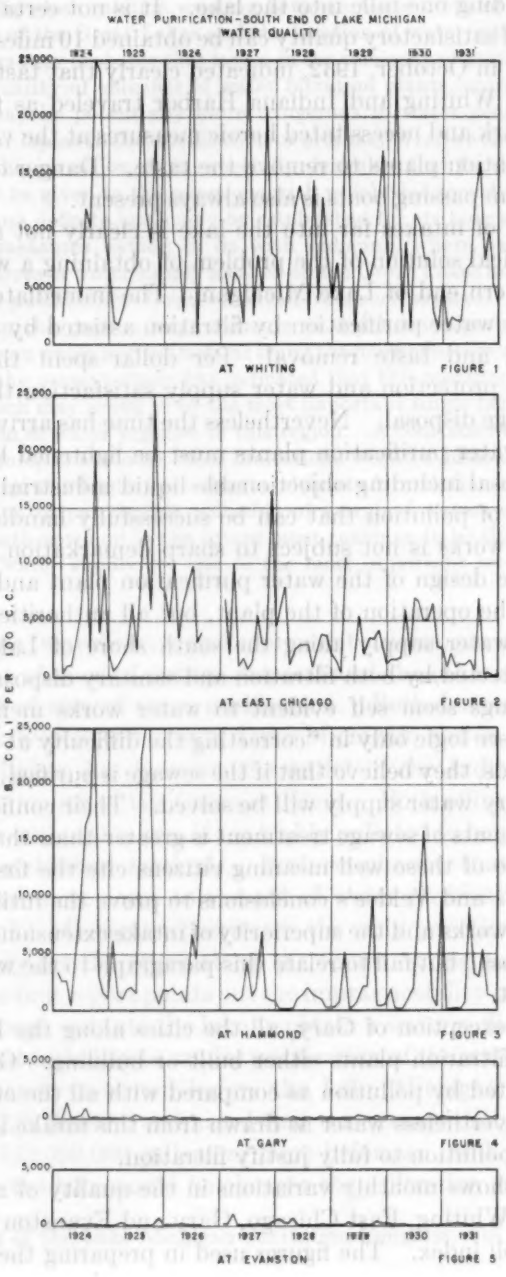
Extension of intakes far into the lake is clearly not an adequate and economical solution of the problem of obtaining a water supply at the southern end of Lake Michigan. The immediate and necessary thing is water purification by filtration assisted by coagulation, sterilization, and taste removal. Per dollar spent this will buy more health protection and water supply satisfaction than will improved sewage disposal. Nevertheless the time has arrived when the burden on water purification plants must be lightened by improved sewage disposal including objectionable liquid industrial wastes.

The limit of pollution that can be successfully handled by water purification works is not subject to sharp demarkation. Much depends on the design of the water purification plant and the human element in the operation of the plant, but all authorities are agreed that every water supply along the south shore of Lake Michigan must be protected by both filtration and sanitary disposal of sewage.

These things seem self evident to water works men, yet many laymen can see logic only in "correcting the difficulty at the source;" in other words, they believe that if the sewage is purified, the problem of satisfactory water supply will be solved. Their confidence in the accomplishments of sewage treatment is greater than that of the experts. Some of these well meaning citizens cite the first paragraph of Crohurst's and Veldee's conclusions to prove the futility of water purification works and the superiority of intake extension or improved sewage disposal, but fail to relate this paragraph to the whole context of the report.

With the exception of Gary, all the cities along the Indiana lake shore have filtration plants either built or building. Gary's intake is least affected by pollution as compared with all the other Indiana intakes. Nevertheless water as drawn from this intake is sufficiently affected by pollution to fully justify filtration.

Figure 1 shows monthly variations in the quality of raw water at Hammond, Whiting, East Chicago, Gary and Evanston as indicated by the B. coli index. The figures used in preparing the charts were


WATER PURIFICATION - SOUTH END OF LAKE MICHIGAN
WATER QUALITY
1924
1925
1926
1927
1928
1929
1930
1931
25,000
20,000
15,000
10,000
5,000
0
B COLI PER 100 C.C.
AT WHITING
FIGURE 1
AT EAST CHICAGO
FIGURE 2
AT HAMMOND
FIGURE 3
AT GARY
FIGURE 4
AT EVANSTON
FIGURE 5

kindly furnished by Dr. F. W. Mohlman, Chief Chemist of the Chicago Sanitary District. All determinations were made in the laboratories of the Sanitary District and are therefore comparable. The most striking feature of these diagrams is the great variation in pollution at the Hammond, East Chicago and Whiting intakes. Contrasted with these, pollution at Gary and Evanston intakes is slight. Changes sometimes take place suddenly without any marked change in the appearance of the water. These changes constitute one of the important difficulties in controlling purification of polluted lake water. Where sole dependence is placed on chlorination the danger of inadequate treatment is especially great and adequate treatment often results in objectionable taste and odor of chlorine.

PROGRESS IN WATER PURIFICATION SINCE PREPARATION OF THE REPORTS OF THE U. S. PUBLIC HEALTH SERVICE

Since the reports herein discussed were prepared there have been several improvements in water purification practice which give plant operators greater control over bacterial content and tastes. These improvements do not eliminate the necessity of improved sewage disposal but do enable the operator to combat the effects of pollution much more successfully.

Most important of these improvements is the introduction of the use of ammonia in conjunction with chlorine resulting in the formation of chloramines. As chloramines do not impart taste, a much greater residual can be maintained without complaint from consumers and with resulting increased sterilizing effect. Because of the slow action of chloramines it is not practical to use them except where there is a filtration plant. Retention in sedimentation basins and clear water reservoirs provides ample time for full sterilizing effect. Other beneficial effects of ammonia in conjunction with chlorine are too well known to dwell upon. Prevention of chloro-phenol tastes and continued sterilizing effect in the mains should be mentioned.

Use of activated carbon to control tastes and odors constitutes another important addition to means available to operators in handling the heavy pollutional load on purification plants at the southern end of Lake Michigan.

New coagulants such as ferric chloride, better understanding of coagulation, mechanical methods of producing flocculation, improved filter washing, and excess chlorination are other means that have become available in the last few years to more effectively remove

pollution. But with all these means we still wish to keep as far away as possible from the necessity of using sewage as a public water supply, however feasible it may be scientifically to convert it into safe and palatable drinking water.

EXPERIENCES WITH THE SEVERAL WATER SUPPLIES AT THE SOUTH END OF LAKE MICHIGAN

A brief running account of the several water supplies at the southern end of Lake Michigan will give a concrete conception of the water supply problems which have confronted these cities for over a quarter of a century, and which will not be adequately solved until sanitary sewage disposal is a reality.

Whiting

The first water purification plant to purify Lake Michigan water in Indiana is at Whiting. This plant was completed in 1920. At the time the plant was built it was realized that tastes and odors must be reduced. Before the plant was built some simple experiments were conducted to determine if aeration would be effective. The tastes and odors at the time were due almost entirely to wastes from oil refineries. The experiments indicated the efficacy of aeration in removing oily taste and odor with the then concentration of pollution. Accordingly the plant was built with spray aerators. The nominal capacity of the plant is 4 million gallons per day. This capacity has been sufficient to meet requirements to date. Because of pronounced turbidities in the water it was deemed desirable at that time to build sedimentation basins of rather large size. They have a retention period of 4½ hours. It was generally believed at the time that 2 hours were sufficient for lake water. The plant is also equipped with a baffled mixing chamber with a retention period of about 4 minutes. The clear water reservoir has a capacity of 900,000, gallons, which is reasonably liberal.

The concentration of wastes from the oil refinery and from other industries increased so rapidly that aeration proved relatively ineffective against tastes and odors. The concentration of the wastes is such that a considerable quantity of oily scum finds it way into the sedimentation basins. Mr. J. F. Bartuska, superintendent of the plant, observed that the oily wastes exerted a selective chlorine demand so that it was necessary to watch closely the chlorine demand in order to insure adequate application of chlorine. The plant has

been skillfully operated and has uniformly furnished a safe water of excellent appearance at all times, but oily tastes and phenol tastes at times have been quite pronounced. In recent years, due to the recovery of phenol at the several places where it is produced, there has been comparatively little trouble from such wastes. Occasional spills, however, do occur. There is no doubt, however, that the pollution at the Whiting intake is much greater than water purification works should be called upon to handle.

East Chicago

The next plant to be built in Indiana is that at East Chicago. This was completed in 1921. The plant had originally a nominal capacity of 8 million gallons per 24 hours which was later increased to 12 million gallons. The intake, until October, 1931, was but 3,000 feet long and obtained water at a point that was grossly polluted by sewage and industrial wastes from the Indiana Harbor Canal. Even with the use of potassium permanganate and ammonia with chlorine it was impossible to remove tastes and odors, particularly those resulting from phenol wastes. Furthermore, the plant was burdened with a great quantity of suspended matter, much of which was of industrial origin. In 1930 the city authorized the construction of a new intake 54 inches in diameter and extending 10,000 feet from shore. The intake is of such size that it may be extended for another 2,000 feet if found necessary or desirable and still meet the probable ultimate requirements of the city. The location of the intake was very carefully chosen on the basis of the studies made by Crohurst and Veldee. While it is not beyond the influence of pollution from the Indiana Harbor Canal, the dilution is much greater and the bacterial load rarely exceeds 1,000 B. coli per 100 cc., whereas previously the bacterial loading had generally been in excess of 10,000 B. coli per 100 cc. The East Chicago plant has a mixing chamber with a retention period of about 2 minutes. Mixing is aided by a hydraulic jump effect. Sedimentation basins have a nominal retention period of about 3½ hours which at the time was regarded as liberal. The clear water shortage capacity is about 2½ million gallons.

Michigan City

The next water purification plant to be authorized for the treatment of Lake Michigan water in Indiana is that now under construction at Michigan City. The water at the Michigan City intake

is not heavily polluted at most times, but, like all water along the southerly shore of Lake Michigan, is subject to sudden wind induced concentrated pollution. Michigan City is in the dunes region and one of the evil results of an unfiltered water supply is accumulation of fine sand in the water mains. This fine sand has a strong erosive effect on corporation cocks, plumbing fixtures and meters. The water supply is not subjected to any pronounced tastes and odors from industrial wastes. The plant will have a nominal capacity of 8 million gallons per 24 hours. It will be provided with a mixing chamber equipped with Dorr flocculators. The mixing chamber will have a nominal retention period of 30 minutes. There are two sedimentation basins with a combined retention period of about 3 hours. Clear water storage is divided between an underground filtered water reservoir at the plant with a capacity of 1½ million gallons and an elevated tank with a capacity of ¾ million gallons.

This plant is equipped with facilities for application of carbon, use of chlorine and ammonia, and for rapid filter wash. The plant is reasonably flexible in operation, but for reasons of economy no provision has been made for double-stage coagulation-sedimentation nor can the sedimentation basins be operated in series. Somewhat greater retention in the sedimentation basins would also have been desirable. The city decision to treat its sewage justifies these limitations in design.

Hammond

Contracts have just been let for a filter plant at Hammond. This plant will have a nominal capacity of 20 million gallons per 24 hours. Mixing chambers equipped with vertical stirring devices will have a nominal retention of about 30 minutes. There are two sedimentation basins with a nominal retention period of 4 hours. The mixing chambers are arranged in two groups. Each group can operate independently with each sedimentation basin. The plant has great flexibility with reference to preliminary treatment, permitting the operation of basins in series or parallel and providing for double-stage coagulation-sedimentation. There are eight filter units, each with a nominal capacity of 2½ million gallons per day. The clear water reservoir has a nominal capacity of 4 million gallons. Longer mixing and longer sedimentation would have been desirable at this plant but the funds available were not sufficient to permit this.

The plant is carefully designed to permit maximum flexibility and

ease in handling the heavily polluted water that comes from the Hammond intake. It may also be readily enlarged and elaborated.

Among the features of the plant is an open flume for the raw water. This permits flexibility in the matter of introducing chemicals and the flume is so arranged that it may be baffled in any way desirable. The chemical feed equipment is unusually complete and permits the use of alum, lime, ferrous sulphate, ferric sulphate, powdered activated carbon, powdered clay or other inert material, chlorine and ammonia. In addition to this, space is provided for the erection of solution tanks and storage tanks, either for experimental work or for the use of chemicals that can be most economically handled in solution such as ferric chloride. Unusually large space for chemical storage is also provided so that sufficient chemicals of all kinds may be kept on hand to meet any situation. The filters are designed for a wash water rate up to 42 inches vertical rise per minute. A rate controller in the wash water line permits limiting the rate of wash water as desired. The filters are also designed to permit the subsequent installation of surface wash in some form if this should become desirable.

STATUS OF SEWAGE DISPOSAL

Progress is being made in removing pollution from the southern end of Lake Michigan. The accomplishments of the Chicago Sanitary District are well known. Works of this District have, in the main, preserved the quality of the water in Lake Michigan effectively. Some uncontrolled pollution still remains that occasionally enters the lake through the mouth of the Calumet River. The North Shore Sanitary District has been working since 1915 to remove lake pollution north of the Chicago Sanitary District; that is, north of the Cook County line and south of the Wisconsin state line. There is now being designed the final and largest of the plants for the District, namely that for Waukegan. With the completion of these works, no untreated sewage will enter the lake from the North Shore Sanitary District. The Waukegan plant will be of great benefit in protecting the water supplies of Waukegan and Lake Forest which now at times must handle an excessive burden of pollution at their respective filter plants. Michigan City deserves the credit of being the first of the Indiana cities to install sewage treatment. Contracts have been let and the construction work is just begun. Sewage treatment works will greatly relieve the burden on the water purification works for Michigan City that have been referred to above. The worst pollu-

tion, however, still remains, namely that between Indiana Harbor and the Calumet River. Not only is this the most polluted area in Lake Michigan but, as already noted, is the most polluted area along the entire Great Lakes. The problem of relieving this pollution is a complicated one, but by no means insoluble. For its successful solution there must be intelligent coöperation among the cities from Gary to Hammond. Furthermore, there must be coöperation of these cities with the Chicago Sanitary District. It is not necessary that sewage disposal of these Indiana cities be handled by one authority, although this has its advantages, but coöperative effort of some sort is necessary so the efforts of one community may not be in part or in whole nullified by other communities. Improved sewage disposal for the Indiana cities from Gary to Hammond constitutes the one remaining problem looking toward improved water supply and the general reclamation of the Indiana lake front. It is vital for the continued use of Lake Michigan as a source of water supply and is pressing for solution now.

(*Presented before the Illinois Section meeting, March 7, 1935.*)

CUSTOMER INQUIRY PROCEDURE

By John A. Bruhn

(*Indianapolis Water Company, Indianapolis, Ind.*)

The evolution of customer inquiry procedure in the Indianapolis Water Company, although interesting to observe, cannot be discussed here because of lack of time. Among other important factors which contributed to changes in the procedure have been, first, managerial policy, second, growth of the city and third, complete meterization. By the subject "Customer Inquiry Procedure" we mean the methods and routine followed in dealing with all classes of water users. Obviously, local conditions in various sections of the country affect materially the details of procedure. However, an explanation of how the subject is currently handled in Indianapolis will be given with the hope that parts may be interesting and helpful to operators of other water plants.

Some time ago we ceased using the word "complaint" and substituted the word "inquiry." Experience has shown that the majority of the people are desirous of making inquiries or constructive suggestions rather than registering complaints.

The population of Indianapolis now exceeds 370,000 and there are approximately 72,500 water accounts in service. Our customers are divided into three main classes. At the present we have about 66,700 domestic accounts which include locations where water is used primarily for domestic purposes, approximately 570 industrial accounts consisting of factories, railroads, laundries, and other similar plants, and 5,230 commercial consumers by which term is meant stores, hotels, hospitals, and all other patrons not found in the two other classifications.

TWO CLASSIFICATIONS OF INQUIRIES

The scope or field covered by customer inquiries is large. They may result from billings, pressure difficulty, leaking meters, freeze-ups, public and private fire protection service, and many other details relating to water supply. In a general way we classify all inquiries

into two large groups, first, those covering information which is immediately available and, second, the ones requiring investigation and in most cases a trip to the location.

INQUIRIES NOT RECORDED

Naturally the most numerous are the inquiries in group one. Based on tabulations kept for a limited time our estimate of the number received last year over telephones and in person is 175,000. They involve such matters as application for and transfer of service, requests for extension of credit, partial payments, information about bills and regulations, duplicate bills and other details. No continuous records are kept on such inquiries since the transaction is consummated at the time of inquiry and no further contact is necessary.

Much progress, however, has been made within the last few years in simplifying and speeding up such service in order to save time and trouble for consumers. A new physical record system was established last year which is much more efficient and convenient than the one previously used. Studies are constantly being made to insure that every reasonable step is taken to eliminate unnecessary "red-tape" and inconvenience for customers. Within the last few months a communicating system was installed between the general business counter and bookkeepers. This aids greatly in taking care of people promptly, especially on days of peak business. The cost and efficiency of this equipment makes it practical and even more satisfactory than anticipated. Just a few days ago a device was placed outside the office entrance which allows payment of bills on Sundays, holidays, before and after regular hours. Another accommodation provided customers which they appreciate is transferring service from one address to another by telephone. There are usually so many details for the mover to attend to at such times that eliminating one trip is helpful. In Indiana water bills are not liens against property. It becomes necessary for us, therefore, to ask persons who do not have deeds or service deposits from previous locations, to come to the office within five days. At that time they are requested to furnish a reasonable deposit (on which interest is paid) or a satisfactory guarantor.

INQUIRIES REQUIRING INVESTIGATION

The second main division of inquiries requires investigations which by their nature cannot be made immediately. Outside calls are

usually necessary. On this type follow-ups in the way of letters or personal contacts are required. During 1934 the average number of such inquiries received each month was 425. The total of 5,060 for the year varied from 252 in the minimum month to 1,263 in the maximum. Among other factors causing such variations are seasonal use of water and sub-zero weather. The following numbers of inquiries were received for the years 1930, 1931, 1932 and 1933 respectively: 4111, 4160, 6443 and 4669.

Beginning several years ago all inquiries necessitating investigation coming to the Indianapolis Water Company, whether by letter, telephone, or directly from consumers, were centralized in the "Inquiry Division" of the Commercial Department. Monthly and annual summaries classifying the inquiries according to cause are made by the Inquiry Division. Through careful study and analysis of these it has been possible to recommend steps which tend to decrease the number of inquiries. This results in more satisfactory service. Many times the Inquiry Division is able to help coördinate the activities of various departments in the organization.

ROUTINE

An inquiry may be received from a customer by any employee in the company. It is immediately recorded on a 5 inch by 8 inch inquiry form and sent in triplicate to the Inquiry Division at the main office. Most of them come in by telephone, some in person, and others by mail. Printed inquiry pads are kept at all company telephones. The employee receiving a call is requested to note all available information on the form. Unless it is a matter of emergency we prefer that customers not be directed to other departments. Two copies of the inquiry are sent at once by the Inquiry Division to the proper investigating department, the third copy being kept as a check to make sure that the matter is consummated within a reasonable length of time. After investigation the original inquiry sheet containing the desired information goes back to the Inquiry Division. The customer is then notified by an individually typed letter or personal call. A copy of the inquiry is kept by the investigating department in case it is needed for future reference. Because the work is well organized and delivery service between departments good, no unnecessary delay results. On special cases instead of writing a letter someone from the company may call on the inquirer to explain the matter. Sometimes the business development repre-

sentative receives information from the Inquiry Division which helps to increase revenue from present and prospective customers.

LETTERS TO CUSTOMERS

Since a fair number of inquiries concern similar or standardized subjects such as leaking meters, defective valves, and service line leaks, we have prepared for the use of the Inquiry Division several form letters. These save much time and with intelligent application work very satisfactorily. At the present fourteen such forms cover the majority of cases. They are all personally addressed, individually typed, and revised once each year so that they do not appear as forms. On unusual inquiries it is, of course, necessary to write individual letters. We follow the policy of thanking by personal letters informants who report matters of interest to the company. Suppose that our Chairman had telephoned us regarding a leak in the street near his home. He would receive within a few days a letter like this:

March 8th, 1935

Mr. C. K. Calvert,
1902 N. New Jersey Street,
Indianapolis, Indiana.

Dear Mr. Calvert:

Thank you for your report of March 6th, concerning the leak in the street in front of your property. A work order has been issued and the necessary repairs will be made.

It is very helpful when a customer informs us promptly about broken connections, burst pipes or any other difficulties of that nature and we want you to know that we appreciate your coöperation.

Please call upon us whenever you feel that anything connected with the water service needs our attention.

Sincerely,
R. F. Dragoo
Inquiry Division.

RFD:RL

Other letters going out from the Inquiry Division are similar to the one just read.

FACTORS WHICH INCREASE THE NUMBER OF INQUIRIES

Most customer inquiries are referred to the Service Department and the special inspector. The unusual cases go to individuals in other departments who are qualified to better understand them. Special studies and attention can logically be given to large industrial

and commercial customers. Complete meterization has affected materially the number of inquiries received. Consumers formerly on flat rate do not realize how much wastage from defective fixtures and heavy use, such as sprinkling, will increase their bills. Having now been completely metered for three years we notice a trend toward a reduction in high bill inquiries. Apparently experience is a good teacher. While on flat rate there were no troubles from leaking, noisy, frozen meters, and very little opportunity for errors in billing. Formerly the maintenance of service lines between property line and main was a responsibility of the property owner through his plumber. A few years ago our company began repairing these. This action has also tended to increase the number of inquiries.

TOLERATING POOR SERVICE

Persons connected with our Inquiry Division have been surprised to find how long suffering and tolerant the average customer is concerning his water service. We find many instances where the delivery of water at fixtures has been very poor for years without any inquiry having been made. After learning of these, sometimes in accidental and indirect ways, we make a flow test at the meter to help locate the trouble. On some of them we find the tap, service line, or curb cock almost closed. For old services incrustation is generally the cause, while in others defective workmanship or material resulted in the sub-normal delivery of water. Often pipe of inadequate size in the customer's plumbing system makes good service impossible. We are glad to assist consumers in obtaining satisfactory service and wish they were less reluctant to report difficulties.

Through our centralized Inquiry Division we are able to make, when necessary, special and thorough investigations of peculiar cases. In some of these interesting and unusual facts have been found concerning consecutive errors in meter reading, underground leaks, increased consumption, meter registration, billing, discoloration, foreign material in the water, and pressure. Experience makes us certain that every inquiry must receive careful consideration. Occasionally a trivial complaint seems to lack good basis, but each is given courteous attention, for usually in the mind of the person it is entirely justifiable. Small increases in bills mean much to persons of meager means. There are, of course, some individuals in every community so constituted that it is not possible always to please them. On the whole, however, American men and women are fair

and will be content when certain they are being treated equitably and courteously.

VALUE OF GOOD CONTACT EMPLOYEES

It is increasingly necessary in these times that the inquiry and other contact employees of a public utility have desirable qualifications and the right kind of attitude toward customers. Because of the nature of our business—being at least partially monopolistic—a fairly general natural prejudice has sprung up. More tact and diplomacy are necessary than in past years to overcome such handicaps A good contact employee should have at least the following qualifications: A courteous, sincere manner, good appearance and education, be efficient and able to take a certain amount of abuse without becoming exasperated even when circumstances are trying. All employees are instructed to justify the necessity for regulations instead of merely appearing arbitrary. High grade work can seldom be obtained through short-term employees either in minor or supervisory positions. In our organization the average length of service of regular employees is twelve years and department heads thirty-six years.

The Indianapolis Water Company has for years been taking its task seriously—to furnish an adequate, dependable supply of purified water under satisfactory pressure at a reasonable and equitable cost. To meet the requirements of every class of customer it is necessary that the supply be free from water borne disease germs, turbidity, and mineral content injurious to boilers or manufactured products; that the pressure be adequate and continuous; and the quantity available in every district be sufficient for ordinary as well as fire protection purposes.

LIBERAL POLICIES

Attention should hereby be called to several matters in which the fair and liberal policy of the management has assisted greatly in maintaining good relations with customers. Meter readers are instructed when finding bills considerably higher with no apparent increased use of water, to make investigations for wastage. Leaks at meters and service lines are also reported by them which save the customer trouble. During the year 1934 more than 10,500 such investigations were made. A special inspector is furnished by the company who helps consumers eliminate unusual difficulties involving wastage, underground leaks, and similar matters. No charges are

made for his services. Although "Rules and Regulations" provide for a reasonable fee for testing meters on requests of customers, this is sometimes waived if the consumer will take the time to witness the test at the Meter Department.

As a general rule it is poor policy to make adjustments or reductions on bills which have been investigated and found correct. A service of value has been rendered at a cost and if not paid for by the original customer must be borne by other patrons who were in no way responsible for the excess consumption. If special consideration and adjustment are given one man, in all fairness the same treatment should be offered others under similar circumstances. Discrimination in service and rates cannot be legally carried out. Because of pumping, purification, and other expense, there is no such thing as free water. Discrimination in favor of one or a few must be borne by all customers. After thorough consideration of the adjustment subject we have adopted the policy of making only one reduction in bills (exclusive of errors). This occurs when there has been a wastage of water from underground pipe which was not visible at the surface. In these cases the company feels there has been no negligence on the part of the consumers. Therefore, the bill is reduced by 50 percent of the excess consumption. Patrons are appreciative of this help in time of trouble.

During the depression a liberal policy has been used in regard to extension of credit, partial payments, and partial deposits to secure immediate service. Meter readers are taking the time this month to stop at every occupied house where the water is off to urge the people to come to the office. Then we endeavor to make special arrangements for service. This all requires additional bookkeeping and expense, but has gone a long way in maintaining good feeling for the company. Many other matters could also be mentioned such as adequate personnel to give prompt turn-on, turn-off, and inquiry service, and routine flushing of dead ends. Printed material is distributed to aid customers in problems relating to water service.

CONCLUSION

In practical operation our present customer inquiry procedure has been found to work smoothly. It is gratifying that consumers often write or personally thank us for our prompt, courteous service. We of the Indianapolis Water Company know that careful treatment of every customer inquiry is a fundamental and vital function of the water supply business.

(*Presented before the Indiana Section meeting, March 8, 1935.*)

INDIANA RAINFALL AND WHAT IS AHEAD

By J. H. Armington

(U. S. Weather Bureau, Indianapolis, Ind.)

In endeavoring to discuss the subject selected for this paper in such manner as to provide something which may be of interest to this assemblage, it is desirable to recognize that it is not particularly *the rainfall*, but the present *lack of rainfall* that is forcing its attention upon us. While lack of rainfall over a large part of the country is of interest, it is that condition as pertaining to Indiana that especially appeals to us. We shall try to keep these things in mind, although it may be desirable to depart somewhat from the strictly local situation because of its relation to conditions in other areas.

It is common practice to refer to any noticeable shortage of rainfall—by which term we mean precipitation of natural moisture in any form, such as rain, snow, sleet, hail,—as *drought*; but when we endeavor specifically to decide just what constitutes a *drought*, we find that exact definition is not so easy a matter. Most commonly, attempted definitions of *drought* are concerned with injurious effects on growing vegetation; but even this explanation is beset with difficulties. Some writers on agricultural subjects have stated that a continued shortage of moisture begins irreparable injury to plant tissues before the damage is shown by wilting, rolling or burning; and yet instances are not particularly uncommon where a crop shows decided evidence of distress from lack of moisture, but is apparently resuscitated by a moderate, slow rainfall which itself is not nearly sufficient to bring the measured fall for the period up to average amount. At times crops on higher lands fail because of lack of a proper amount of water, while under the same rainfall those on adjacent lowlands grow luxuriously to maturity; and again, sometimes vegetation on light soil deteriorates because of dryness while in the same locality and from the same rainfall heavier soil retains ample moisture for plant needs.

Then, too, the question of subsoil water may be taken into consideration in determining a period of drought, and I take it that it is

this particular point that is of concern to the Indiana Section of the American Water Works Association. So far as I am aware, however, knowledge of past subsoil conditions is not available in the form of definite quantitative measurements uniformly and continuously made over any considerable period to parallel the records of rainfall for this section. If any such are in existence, possibly they are in the possession of the membership of this body, and it would be a matter of much interest, undoubtedly, to link them up with the data on past rainfall.

RAINFALL RECORDS

Without attempting, therefore, to set any limits for the term *drought*, we shall proceed to discuss briefly the conditions of rainfall in Indiana as indicated by the records in the possession of the Weather Bureau, beginning with the year 1887, with which year the official State-wide weather service was inaugurated.

About 30 rainfall recording stations were contributing in the first year of operation of the State service, rather uniformly distributed, but still with a greater number in the older southern division than in either the central or northern counties. This small number has been gradually increased during the succeeding years until at present there are 88 stations within the boundaries of the State making daily observations of rainfall, and reporting at least monthly to the section center at Indianapolis. Eighty-eight stations seem like a large number for this work, but really a much larger number might serve to considerably better advantage in securing a proper amount of data concerning the distribution of precipitation.

We are not nearly so well off as is Great Britain in the matter of measuring and recording rainfall, as may be appreciated by the following comparison: Indiana, with its 36,354 square miles of area, has 88 rain gages in operation. According to the London *Times* in an issue of the spring of 1932, Great Britain, with an area of 88,754 square miles, had in operation nearly 8,000 rain gages. If Indiana had as many gages per unit area as does Great Britain, we would number 3030 rain gages in the State; if Great Britain had the same number per unit area as does Indiana, its nearly 8,000 gages would have to be decreased to the considerably smaller number of 212. It may be worth noting that in Great Britain most of the observers buy their own rain gages, and any other meteorological equipment they may use; in this country it is the rare exception, and not the rule by any means, for weather observers to be so inclined.

SOURCES OF RAINFALL

Without much question, the main source of moisture which is deposited as precipitation over Indiana is the Gulf of Mexico. Water from the surface of the Gulf is evaporated into the warm overlying air, which carries it inland up the Mississippi Valley; thence, turning to the eastward under the influence of the prevailing higher westerlies and the rotation of the earth, the warm moisture-laden currents sweep over the Hoosier State. If, on their approach, as is often the case, they encounter heavier, indrafted air from the Canadian country, or a mass of air cooled by continued radiation from a snow surface, etc., these warm moist currents run upward over it in inclined fashion. In gaining altitude, they expand and lose temperature, soon cooling themselves to and past the saturation point, with the resultant formation of clouds and rain.

This explains why the main rain-bearing winds in this State are from southwest to south; and also why precipitation is not infrequent with the coming of cool or cold winds from west to northwest, these latter simply forming the inclined plane that serves to elevate the warm moist Gulf air above the condensation level.

The question is often asked if the evaporation of moisture from moist soil surfaces to the windward of the State—say from Kentucky, Illinois and Missouri to Louisiana, Texas and Oklahoma—is not one of the important sources of Indiana rainfall. Such evaporation without doubt has some effect in providing moisture for our area, but only to limited extent; and it is to be noted that substantial rains do fall over Indiana when the soil surfaces to the windward southwest have been comparatively dry during the immediate past. The main source of moisture for these southwestern regions is also the Gulf of Mexico, and whatever rainfall comes to Indiana as a result of evaporation from their soil is simply relayed to us from the original source in the Gulf.

The question is also asked as to whether our own streams and lakes are not largely returned to us in the shape of rainfall, and whether any lessening of the surface of these water areas by dredging and drainage must not certainly deprive the State of an important amount of its rainfall. Any rainfall occurring in Indiana as a result of evaporation from the surfaces of its streams and lakes is a practically negligible quantity. For the moisture from these local sources to evaporate into the atmosphere in the form of water vapor, a comparatively warm and dry wind must blow over the water surface,

and must continue for some time in order to take up any substantial quantity of moisture. If it could be immediately elevated above the condensation level it would of course begin to send that evaporated water back in the form of rain; but by the time this elevation occurs in the course of natural processes, the water vapor has been transported far beyond the boundaries of the State, and, indeed, beyond the confines of its immediate neighbors.

There is, however, one process through which substantial amounts of moisture from near-by sources are visited upon the northern areas of the State, usually in the form of heavy snows. It is typically to be noted in the vicinity of Lake Michigan in the winter season. When, in a period of cold weather, the temperature of the land and air over the northern end of the State is moderately below the freezing point, and the water of the lake surface is somewhat above the freezing point, any wind blowing over a considerable extent of lake water will be warmed and receive moisture by evaporation. When it reaches the shore, its own density having been lessened by warming when over the Lake, it tends to run aloft over the denser, colder air over the land as up an inclined plane. Thus it soon rises above the condensation level, and precipitation begins, which reaches the surface in the form of snow. Instances are not at all uncommon in which such Lake winds pile deep snows up in long wide ridges. The width of the ridge of heavy snow appears to be determined somewhat by the direction of the Lake wind as it blows over the long, narrow Lake.

Permit me now to repeat that the main source of rainfall for Indiana is the Gulf of Mexico, and that other sources are comparatively unimportant, except upon occasions rare enough as not to affect materially the general average. The direction of the wind, whether from the Gulf of Mexico, the Canadian plains, or wherever, is determined by the distribution of barometric pressure. Therefore, whatever distribution of barometric pressure produces winds from the Gulf of Mexico blowing generally northward and northeastward up the Mississippi and Ohio valleys, brings about also the importation of water in the form of vapor sufficient for our rainfall—and this rainfall will occur in Indiana if the additional requisite mentioned in a preceding paragraph is present; namely, a bank, edge, or front of denser, colder air positioned to loft this warm, moist, Gulf current above the condensation level as it passes over the State.

BAROMETRIC PRESSURE EFFECTS

Everyone more or less understands the general effect of areas of varying barometric pressure. These are a familiar sight on the Daily Weather Map, where they are marked as *highs* and *lows*, respectively. Their relation to one another at any given time determine the direction of movement of the lower stratum of air, or the evaporation layer, to a considerable height above the earth's surface, usually up to and somewhat above the condensation level—for which reason lower cloud types mostly are noted as moving in the same direction as the wind at the surface. High barometric pressure is characteristic of masses of denser, cooler air, mostly moving over the United States from the colder regions of Canada and Alaska; while low barometric pressure is characteristic of masses of less dense and comparatively warmer air with more varied avenues of approach than *highs* usually show. In consequence, the movement of the lower stratum of air, must be initially outward from the dense, cool area of high pressure, and inward toward the nearby area of low pressure. The moment this movement begins, however, the force of Earth's rotation steps in, and apparently turns the current to the right—in the northern hemisphere.

This fact is voiced in the law announced by Buys-Ballot, Dutch Meteorologist, in 1857: that if one stands with his back to the wind, the area of high pressure will be in the direction of his outstretched right arm, and the area of low pressure in the direction of his outstretched left arm.

In fact, this deflection to the right is continued until the wind assumes a motion parallel or nearly parallel to the lines of equal barometric pressure as sketched on the map, and no longer directly across them from the *high* toward the *low*.

Since the initial movement of air from a high pressure area is outward in all directions from its center toward surrounding areas of low pressure, it is evident that whenever a large high pressure area moves to the southward of the State of Indiana in its general course eastward, it must effectually prevent any moisture-laden air over the Gulf of Mexico from blowing northward and northeastward up the Mississippi and Ohio Valleys. And, further, no warm, moist Gulf air can be so imported as long as this condition of pressure prevails. Under such a situation we may rightly expect a diminution of rainfall over the regions thus cut off from the main source of their supply.

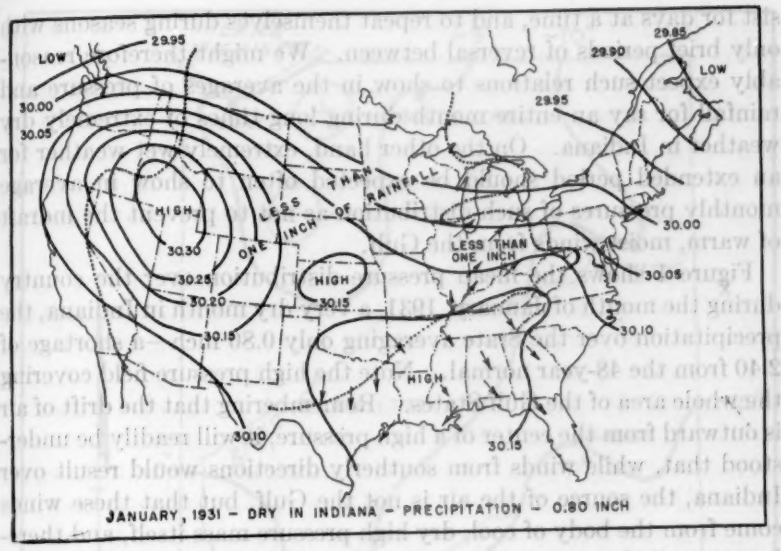


FIG. 1

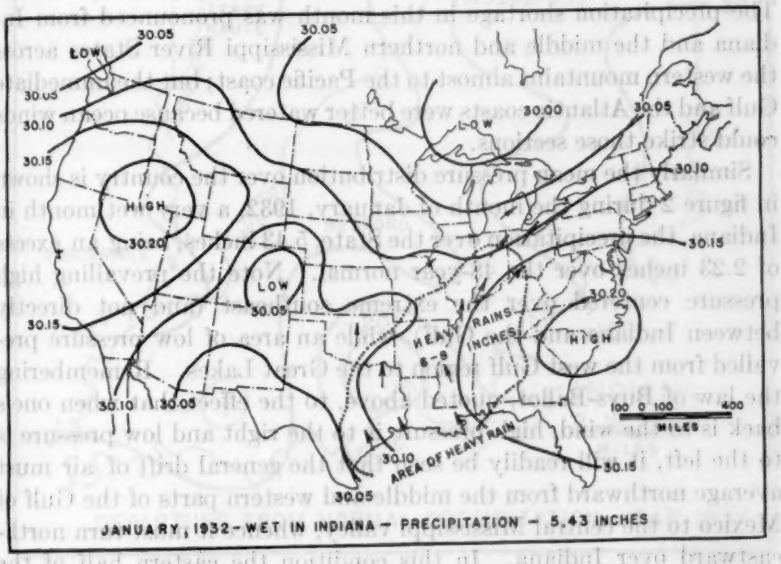


FIG. 2

What is to be noted in the individual case mentioned here is to be noted also during extended times when such pressure relations per-

sist for days at a time, and to repeat themselves during seasons with only brief periods of reversal between. We might therefore reasonably expect such relations to show in the averages of pressure and rainfall for say an entire month during long times of extremely dry weather in Indiana. On the other hand, extremely wet weather for an extended period should be expected often to show in average monthly pressures of such distribution as not to prevent the indraft of warm, moist winds from the Gulf.

Figure 1 shows the mean pressure distribution over the country during the month of January, 1931, a very dry month in Indiana, the precipitation over the State averaging only 0.80 inch—a shortage of 2.40 from the 48-year normal. Note the high pressure field covering the whole area of the Gulf States. Remembering that the drift of air is outward from the center of a high pressure, it will readily be understood that, while winds from southerly directions would result over Indiana, the source of the air is not the Gulf, but that these winds come from the body of cool, dry high pressure mass itself, and therefore carry little or no moisture to be precipitated over northern areas. The precipitation shortage in this month was pronounced from Indiana and the middle and northern Mississippi River States across the western mountains almost to the Pacific coast; but the immediate Gulf and the Atlantic coasts were better watered because ocean winds could strike those sections.

Similarly the mean pressure distribution over the country is shown in figure 2 during the month of January, 1932, a very wet month in Indiana, the precipitation over the State, 5.43 inches, being an excess of 2.23 inches over the 48-year normal. Note the prevailing high pressure centered over the extreme southeast (and not directly between Indiana and the Gulf), while an area of low pressure prevailed from the west Gulf region to the Great Lakes. Remembering the law of Buys-Ballot, quoted above, to the effect that when one's back is to the wind, high pressure is to the right and low pressure is to the left, it will readily be seen that the general drift of air must average northward from the middle and western parts of the Gulf of Mexico to the central Mississippi valley, whence it must turn northeastward over Indiana. In this condition the eastern half of the country received considerable moisture generally, with the area from Indiana to the middle and west Gulf coast especially favored by generous rains.

It is possible, of course, for pressure relations to be such that one

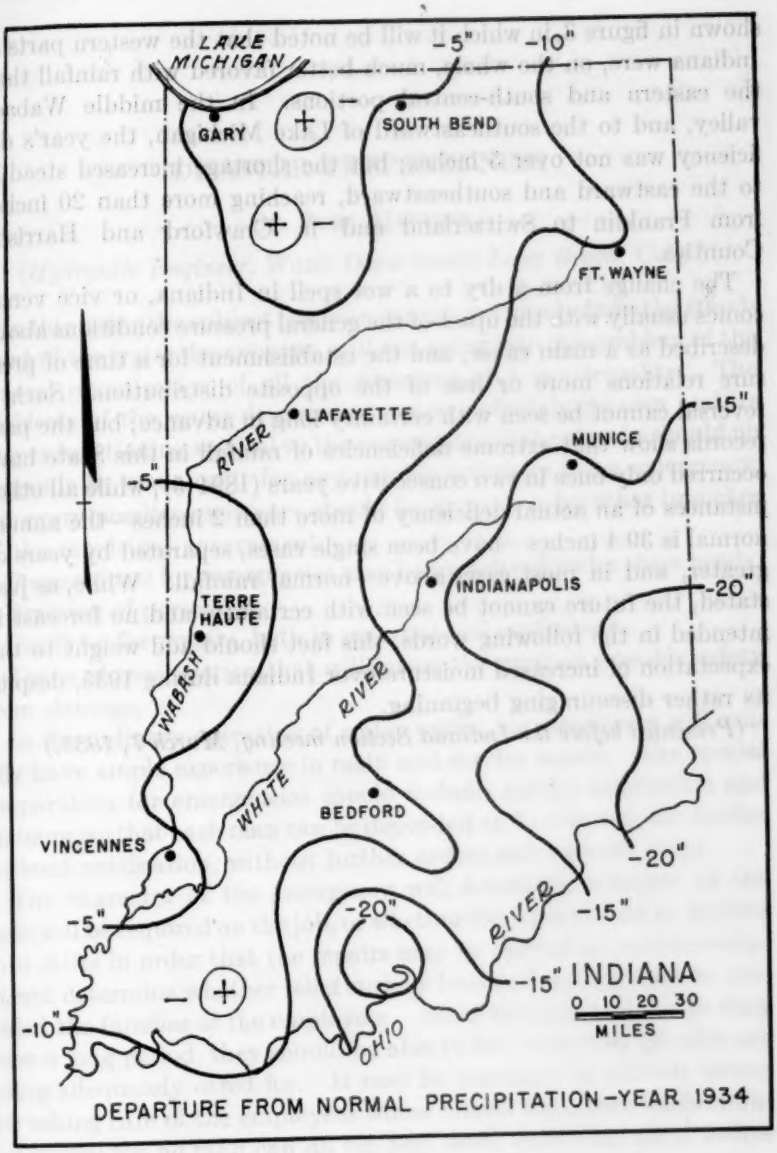


FIG. 3

part of the State is visited by a greater amount of rainfall over say a year's time than the remaining portions. Such was the case in the year just closed, 1934. The precipitation shortage for the year is

shown in figure 3, in which it will be noted that the western parts of Indiana were, on the whole, much better favored with rainfall than the eastern and south-central portions. In the middle Wabash valley, and to the southeastward of Lake Michigan, the year's deficiency was not over 5 inches; but the shortage increased steadily to the eastward and southeastward, reaching more than 20 inches from Franklin to Switzerland and in Crawford and Harrison Counties.

The change from a dry to a wet spell in Indiana, or vice versa, comes usually with the upset of the general pressure conditions above described as a main cause, and the establishment for a time of pressure relations more or less of the opposite distribution. Such a reversal cannot be seen with certainty long in advance; but the past records show that extreme deficiencies of rainfall in this State have occurred only once in two consecutive years (1894–5); while all other instances of an actual deficiency of more than 2 inches—the annual normal is 39.4 inches—have been single cases, separated by years of greater, and in most cases above—normal rainfall. While, as just stated, the future cannot be seen with certainty, and no forecast is intended in the following words, this fact should add weight to the expectation of increased moisture over Indiana during 1935, despite its rather discouraging beginning.

(*Presented before the Indiana Section meeting, March 7, 1935.*)

DISASTER PREPAREDNESS

By Burt Harmon

(Hydraulic Engineer, Water Department, Long Beach, Calif.)

In this paper the subject has been considered purely from the standpoint of the water department, without going into the problem of the general organization of all the resources of a municipality. The problems of the water department are so definitely its own and its proper functioning so vital to the community that not only should no demands be made on it for any outside activities in an emergency, but every possible assistance should be given to it by other branches of the municipal government.

Preparedness for emergencies may be considered under these heads:

Training of personnel.

Facilities for repairs, both in material and equipment.

Types of construction that will insure the greatest possible safety from damage.

In the ordinary operation of water works, the employees will usually have ample experience in main and service repair. The special preparation for emergencies should include careful instruction and training, so that each man can be depended on to report to his station without notification, without further orders and without delay.

The character of the emergency will determine whether all the men will be required on the job, or whether the force should be divided into shifts in order that the repairs may be carried on continuously. It will determine whether relief such as food and shelter must be provided the families of the employees. Since the men may be on duty over a long period, they should be able to feel that their families are being adequately cared for. It may be necessary to provide means for taking care of the employees whose homes have been made uninhabitable; for no man can do his best work unless his mind is free from worry about his own or his family's welfare.

In providing facilities for repairs, the most important item is replacement stock. A sufficient amount of each size and kind of pipe in the system should be kept as a separate supply, to be drawn on

only for emergencies. It will lessen the temptation to "borrow" with the intention of replacing at some convenient time, if this supply is kept at a location separate from the regular stock.

Tools and equipment will be the same as that required in the regular operation of the water system. An ample supply should be maintained.

Another important item is to have available some mechanical means for closing the larger gate valves. A 30-inch geared valve may require an hour or more to close by hand. If such a valve can be closed in five or six minutes by mechanical equipment, the necessity of such equipment is obvious. Trained personnel for the operation of the equipment should be available.

It is unfortunate that there is little of proven worth that can be done to protect water mains from damage due to earth movements. We may recognize certain locations as hazardous, but it is seldom possible entirely to avoid such locations. We must serve consumers wherever they see fit to build their homes.

We are frequently unable to avoid crossing known fault lines with trunk mains, although we know that any appreciable movement along that fault will result in the destruction of the main. We can sometimes avoid the risk of carrying all our eggs in one basket by using a number of smaller trunk lines—as widely separated as possible—rather than one large main. Mark Twain once remarked that it "might be better to put all one's eggs in one basket and then watch that basket." I think, however, that we are all agreed that a greater measure of safety can be attained by the use of a larger number of baskets with fewer eggs per basket. If we have an accurate knowledge of the hazardous points, conveniently located repair facilities, and a carefully worked out plan of repair, we have done all that we can toward meeting an emergency.

It has been suggested that, as a measure of safety, large mains might be laid at greater depth. John R. Freeman, in his work on Earthquake Damage and Earthquake Insurance, states: "Earthquake waves . . . . probably have smaller amplitude at great depths than near the surface, and probably the amplitude of transferred waves in soft, mobile ground is much smaller at 20 feet depth than on the surface." Evidence that there is increased safety with depth was shown in the Long Beach system where more than six miles of 20-inch cast iron pipe in alluvial soil, laid at a depth of 76 inches, passed through the 1933 earthquake with no fractures, and with only

one separated joint. At several wells concrete pump bases were fractured while the well casing below was not affected.

But with increased depth comes increased difficulty of repair. And our saving in the total number of breaks might be more than offset by the increased time and effort required to effect repairs to such breaks as do occur.

There is a wide range in the destructive effect of earthquakes on underground structures in different types of soil. Hard packed earth such as clay or adobe, not adjacent to fault lines, is reasonably safe, while alluvial soils or artificial fills, particularly those carrying ground water, form a highly unstable base for pipe lines. Any change in the character of the soil, such as going from hard packed earth into loose alluvium, or passing through fills of uneven depths, is apt to form a hazardous point. Breaks in loose alluvium or fills seem to come from settlement due to further compacting of the soil by the shaking of the ground, rather than from lateral movement.

Where the change in the character of the ground is abrupt and well defined a judicious use of some type of flexible coupling might be indicated. Flexible couplings are also advisable when connecting an underground main to a rigid structure such as a tank or pump. In the earthquake of 1933 it was noted that mains laid in a line between rigid anchors were inclined to fracture while lines of the same material, free to move longitudinally suffered but little.

Another item of great importance is the number and location of gate valves. I need not mention the desirability of being able to confine the effect of a main break to a single block. This isolation is all the more vital when the number of breaks has been multiplied many times by an earthquake. It is of equal importance that gate valves can be readily located and that they will work when needed.

While there is no known method of insuring the safety of underground pipe lines, that is not the case with other structures. Key buildings such as those housing pumping machinery can, and should be made fireproof and earthquake resistant. The Long Beach Water Department has adopted all steel construction for booster plants, and light wood or steel frame stucco for the small 10 feet by 20 feet buildings housing the well pumping machinery. Steel or wrought iron pipe should be used for all connections between pumps and underground mains, with flexible joints for additional safety.

Our own experience last year served to emphasize these points:

Have sufficient replacement stock in a convenient location.

Have gate valves that will work and have them in the right places.

As far as possible avoid filled ground and loose alluvium with trunk mains.

Make your buildings safe.

STAND-BY PLANTS

In this paper I have not gone into the subject of stand-by plants. The necessity for those will depend to a large extent on the reliability of the regular power installations, which is not a problem in this area.

As long as a water main remains intact, carrying water under pressure, it is obvious that there is no danger of pollution from outside sources. It is equally obvious that a broken main is not a source of danger so long as no water can be drawn from it. The critical point comes when a main is put back into service after having been repaired.

An earth movement sufficient to rupture water mains would be very apt to fracture sewer lines in the same area and it is unthinkable to resume service in such mains without thorough disinfection. Some type of portable chlorinating apparatus equipped to inject chlorine against some pressure is essential for this work. All house taps should be closed before the main is filled and not opened until the main has been chlorinated, flushed and rechlorinated.

It is possible to inject the chlorine through a fire hydrant, but it is more effective to install a corporation cock in the main for that purpose.

Another problem that must be faced by a water department in the event of a major catastrophe is that of communications. We do not realize the extent to which we depend on the telephone until it is no longer available, and we are forced to find some other means of rapid communication.

Messengers are probably the most reliable substitute, and there is little difficulty in organizing an efficient bicycle messenger service.

The most effective substitute for the telephone would probably be a short wave radio. A few cars equipped with two-way sets of the type that has been adopted for police work might be the solution of that problem. But while it may be of great value when properly used, radio has not always proved an unmixed blessing. The amount of misinformation that can be broadcast by an irresponsible announcer was demonstrated in our little trouble of March, 1933.

One is inclined to approve the solution offered by Will Rogers that —"the first thing to do in any disaster is to run—don't walk but run —to the nearest radio, and shut it off."

(*Presented before the California Section meeting, October 25, 1934.*)

THE EMERGENCY TREATMENT OF WATER SUPPLIES FOLLOWING MAJOR CATASTROPHES

By R. F. Goudey

(Sanitary Engineer, Bureau of Water Works and Supply, Los Angeles, Calif.)

Southern California has been experiencing local catastrophes about once every two years, including the Santa Ana typhoid fever epidemic, Santa Barbara earthquake, St. Francis Dam disaster, Long Beach earthquake and the Montrose flood. Curiously, the greatest stress on emergency treatment has been where the supplies were the safest and in the one case where contamination was the most severe neither was the water treated nor the public warned. It is well, therefore, to review these calamities and be guided by the lessons which can be gleaned from them.

SANTA ANA TYPHOID FEVER EPIDEMIC

The 1924 typhoid fever epidemic at Santa Ana was a catastrophe because it affected every person in the city, involved an economic loss of over a million dollars and killed over fifty people. The first indication that something was wrong occurred the day before New Year's Day when practically everyone in the city suffered from vomiting, diarrhea and severe prostration. Service at the telephone exchange, department stores and many places of business was paralyzed because of the employees being out sick. No alarm whatever was sounded in spite of the unmistakable warning that water alone could account for such a disaster. Instead, rustlings of questionings were hushed, no preventive measures were taken and the city bore the full brunt of the disaster. Emergency treatment could have helped and had the city been chlorinating its supply and had it increased the chlorine dose when trouble was first noticed the consequences would have been far less serious.

Emergency treatment was not started until five weeks later when as a last resort sewage was deliberately backed up in the main outfall sewer in front of the water plant to an elevation indicated as a recent

high water mark which resulted in the supply being re-polluted. The writer found sewage under these conditions literally pouring into the top of a hidden air-lift well from a flooded pit around it. The well was being pumped into a surface reservior before entering service. Instead of the well pit being hooked up with the safe drainage system common to the others and independent of the sewer system this one well had been connected to an abandoned sewer long since forgotten which connected to the outfall sewer. The inference was that on December 29, 1923 during a storm, sewage contaminated the well such that on the following day one-third of each glass of water used for drinking purposes was sewage.

This discovery called for action. Five commands were given in less than a minute's time. The contaminated reservoir and well were cut out of service. Another pump from a safe source was started. A man was detailed to have the telephone company notify all subscribers that the supply was polluted and also to report the matter to the local newspaper. Another person was instructed to collect bacteriological samples all over the city as soon as possible. Finally the order was given that the supply would be treated. Unable to obtain liquid bleach at the nearest laundry we picked up five cases of chloride of lime at the local wholesale grocery warehouse. Ten cartons were opened at a time, mixed into a paste in a three gallon pail, diluted to a milk and poured from a quart measure into the suction side of the pump at a uniform rate while another batch was being mixed. Inside of twenty minutes after sewage was seen entering the supply a slug of chlorine with a continued dose of 40 pounds per million gallons for two hours was pumped into the distribution system. In the meantime we set up two 40-gallon barrels and a redwood orifice box in which liquid bleach was used at a rate of one part per million. Later in the day a porcelain box with a regulating orifice was installed and a lower dose was used. The effectiveness of the emergency treatment was seen when the sample collector reported free chlorine at all taps he visited and in no instance did any of the samples indicate contamination.

It is obvious in this case that the city officials failed to recognize the catastrophe when it struck, neglected to make the proper investigations, had no chlorination equipment available and left it up to State officials to ferret out their troubles. Since then a full time health department has been established.

SANTA BARBARA EARTHQUAKE

During the Santa Barbara earthquake there were some breaks in the distribution system, Sheffield Reservoir was washed out, newspapers had the supply polluted and contrary to the advice of the Health Officer and Water Superintendent the public was warned to boil all drinking water. The writer, on the day of the disaster, was ordered to Santa Barbara to confer with the City Manager, inspect the water system, treat the supply if necessary, and take such steps as might be required to restore public confidence. I found that the few breaks had been isolated without loss of all pressure, that Sheffield Reservoir was being by-passed with chlorinated water, and that the chlorine dose had been increased after the earthquake. The notice of boiling water, therefore, was unfounded. At once, I collected bacteriological samples, one group for analysis by myself at the local laboratory and the other for the State laboratory at Berkeley. All the twenty-four hour presumptive tests indicated that the supply was safe and public statements were made to that effect.

In this instance local newspapers and officials refused to take the word of their Health Officer and Water Superintendent and apparently appreciated an outside authority reviewing their problem.

ST. FRANCIS DAM DISASTER

Following the flood in Santa Clara Valley from the failure of the St. Francis Dam, telephone operators and newspaper reporters, without any official sanction, had the water supplies of Piru, Fillmore, Sespe, Santa Paula, Saticoy and Camarillo polluted and broadcasted that all drinking water should be boiled. The writer, on orders from the Secretary of the State Board of Health, left on the same day with two chlorinators, fittings and a supply of chlorine gas prepared to make a complete survey of these water systems, to treat those needing it, and collect samples for bacteriological analyses. This was accomplished in less than a day for the simple reason that all but one of the supplies were untouched. At Saticoy the crests of some of the waves barely splashed into a surface reservoir and it was quickly disinfected with chlorox obtained from a local grocery store. The bacteriological samples showed all the supplies were safe for drinking purposes. The newspapers published the results and the public confidence was immediately restored.

On the day following the flood it was found that the sewage from Santa Paula was being carried by receding waters past a number of

private wells and dairies. The writer, with the assistance of representatives from Wallace and Tiernan Company, set up a chlorinator using gas furnished by the City of Los Angeles to disinfect the sewage.

Under Mr. C. G. Gillespie's direction a number of private wells were treated with chloride of lime by sanitary inspectors and one by one were restored to safe usage.

In this disaster there was an utter lack of central authority except that brought in by State officials and for that reason newspapers were at their worst. The need of an emergency organization was obvious. The value of bacteriological analyses of samples collected on the day of the disaster was definitely proved.

LONG BEACH EARTHQUAKE

About the very first announcements over the radio and by the newspapers in regard to the Long Beach earthquake was that all water supplies in the stricken area were polluted and that all drinking water should be boiled. In fact, these appeals were as frantic as they were frequent and had the public really believing the water was dangerously polluted. This advice was probably correct for seventy-five per cent of the population outside the city of Long Beach but was absolutely incorrect for the city itself.

The writer was called over the radio by Dr. C. W. Decker, former Health Officer of the City of Los Angeles, just twenty-three hours after the first shock and was instructed to report to Long Beach and straighten out the water situation. Dr. Decker held the position of Medical Director of the devastated area and was in charge of first aid, relief work and water supplies.

In less than an hour's time and after securing approval from Mr. H. A. Van Norman, the writer reported at Long Beach accompanied by Mr. Roy O. Van Meter. Dr. MacDonald, the Health Officer, advised that he had turned everything over to State officials who would arrive in forty hours and in the meantime he recommended boiling of the water and was satisfied. The writer then found Mr. Fred S. Porter on the job and reviewed what had happened. The main part of the city never was without pressure and the sources were free of pollution. The small Belmont Shore and Naples sections of the city were without water because numerous breaks required them to be isolated. The order to boil water in Long Beach, therefore, was without foundation.

At midnight we decided to treat the supply to remove any ques-

tions as to its danger. Inside of forty minutes we set up a portable truck chlorinator which only had to be transported from Wilmington and treated all the supply entering service. The following morning residual chlorine was picked up in the south and east sections of the city. Bacteriological samples, seventy-seven in number, were collected all over the city. The twenty-four hour results were negative and on the morning of March 13 just three days after the earthquake, a bulletin was given to Dr. Decker giving definite assurance that the supply was and had been absolutely safe for drinking purposes.

The portable chlorinator proved its worth. By connecting to a fire hydrant this machine could pump 750 pounds of chlorine per day against 250 pounds per square inch pressure. The portable was kept at its first location until a semi-permanent installation by Wallace and Tiernan representatives was completed. It was then moved to the business district where chlorine was pumped to taps in the west portion of the city. It also operated at fire hydrants in the Belmont Shore area for three weeks until repairs in that system were completed.

When State officials did arrive they took over the water supply for the Naples and Belmont Shore areas and did excellent work in locating water tank trucks, disinfected the tanks, and delivered free water to residents who brought out their utensils to be filled in a sanitary manner as the trucks slowly patrolled the streets.

In this disaster it is to be noted that the Health Officer unduly alarmed the people, neglected to consult with the Water Department, and refused to coöperate with any scheme of emergency treatment prior to the arrival of State officials. The weakness of voluntary relief work under such a reactionary official was quite apparent. The city had no chlorinators or any treatment equipment with which to cope with the situation.

In the County territory and affected cities outside of Long Beach, most effective emergency work was accomplished. Never before in the history of California were more chlorinators set up, wells and tanks disinfected and water supplies restored. Officials of the County Health Department, representatives of chlorination companies and water works men in responsible charge all acted promptly and wisely. Perhaps the most common trouble experienced was the finding of suitable places to chlorinate on small supplies. The County Health Department is now recommending installation of corporation cocks and availability of lines at all strategic points. While it was advisable to order boiling of water in the area it was unfortunate that

the agencies used to disseminate that knowledge covered other sections where it did not apply and this should be taken into account in the future.

MONTROSE FLOOD

Waters from the Montrose Flood topped a number of wells, entered exposed broken mains of the distribution system and considerable emergency work was needed in the Glendale and Montrose areas. The County Health Department, through Mr. H. A. Jewett, made such a quick inspection of these supplies, disinfected them with hypochlorite so that before sanitary inspectors of the same Department could come along and collect bacteriological samples all supplies were found to be safe for drinking purposes. Prompt action of this type is highly commendable. The same flood in the City of Los Angeles caused muddy water in some of the reservoirs and Dr. C. W. Decker, the Health Officer at that time, ordered the drinking water to be boiled. He did this after consulting with the Department in which it was brought out that the storm water was not dangerously polluted, that chlorine doses had been sufficiently raised to overcome any pollution which might have entered, and that in our opinion there was no need for any alarm. This conclusion was later borne out by bacteriological findings. Dr. Decker modified the order stating that the water was probably safe but that if anyone wished an additional safeguard boiling would give it to them. If took many months for public confidence to be again restored in the city supply and even today there is an occasional inquiry as to whether the water still needs to be boiled.

GENERAL

There is no assurance that catastrophes will not continue to visit Southern California at fairly regular intervals. Definite steps should be taken to meet them with a proper organization. Each case will be different and will require special consideration. There are certain fundamentals, however, which are common to all.

First. There is a need to recognize catastrophes involving pollution of water as soon as they occur. When a large percentage of the population of all age groups is suddenly attacked with stomach disorders, diarrhea, and severe prostration it is well to assume that water is to blame whether it is or not and act accordingly.

Second. There is need to recognize emergency organizations which

correlate city and county activities in order to avoid all possible conflicts. Wild newspaper stories, exaggerated radio announcements and all early publicity should be censored and only accurate information should be given.

Third. Health officers and other officials should absolutely be prohibited from ordering water to be boiled until the General Manager or Water Superintendent has given his permission and the latter after he has received a report as to the exact condition of the water supply.

Fourth. Each water department should have either the full time services of a sanitary engineer or should have engineers or inspectors of City, County and State Health Departments who are thoroughly familiar with their supplies and are available to make reports following emergencies.

Fifth. Each water department should have available a reserve chlorinator, supplies of gas and hypochlorites and any necessary fittings required for emergency treatment. Each department should list all the chlorinators used for swimming pools in its vicinity which might also be used in case of emergencies. The person responsible for the safety of the water should be familiar with all methods of disinfection, including the crudest of using calcium hypochlorite with the meagerest of equipment, homemade affairs using bleach solutions with orifice boxes, up to the latest types of portable equipment.

Sixth. Each small water department should provide at once corporation cocks at strategic points where its supply could be chlorinated on short notice.

Seventh. Immediately at the outset of any catastrophe bacteriological samples should be taken for analysis and the public should be kept informed of such results from day to day. Supplies of sterile bottles and bacteriological equipment should be cached for emergencies.

(*Presented before the California Section meeting, October 25, 1934.*)

LAYING WATERMAINS IN ROCK FORMATION

By F. G. Browne

(Engineer, Teck Township, Ontario, Can.)

In presenting this paper an effort will be made to deal more with the unusual difficulties encountered in the mining country of the North.

The program reviewed was undertaken as an unemployment relief scheme under the supervision of T. M. McIntyre during the winter 1933–1934 and 4 sub-foremen and 3 pipe layers were the only skilled men employed. The balance were drawn from the local relief office. Forty cents an hour was the minimum wage for an 8 hour day and men were paid in cash and were required to do a regular day's work. Failing that they were turned back on a reduced direct relief. Considerable trouble was encountered at first, but after it became clearly understood that a day's work was required, little trouble was experienced.

Another problem peculiar to a rough country like ours is the very uneven topography. It would be economically impossible to get an even grade from one end of the street to the other. This makes it necessary to reserve rights of way in the sub-divisions and complicates the lay-out.

In planning the work it was realized that ample provision would be needed for compressed air. The use of gasoline was out of the question. This matter was solved by the purchase of an Ingersoll Rand Model 2–50, 2 stage air-cooled moto-compressor, electric driven. This is a 6 cylinder machine directly connected to a 50 HP 550 volt Induction motor and has proved to be "the contractor's dream come true." It has required practically no upkeep costs. This machine furnishes ample air for two Holman sinkers which have a 3-inch cylinder.

The complete compressor plant is portable and is on skids. The compressor and starter are on one set of 8 x 8 skids and two 25 KVA transformers on another set of skids, with a sectional shack to house the compressor.

At one stage of the construction, the air was piped 2000 feet by

using two air receivers, one at the compressor plant and one near the rock drills. This machine gives very dry air and practically no trouble was experienced with freezing of air lines.

In the operation of this compressor it was found that, due to the shack being unheated at night, it was necessary to install a small industrial 2 k.w. heater under the crankcase to prevent the oil from becoming too stiff to start in the morning. The power costs on this plant per 8 hour day were $8.57. This is based on a rate of 1¾ cents per k.w.h., plus $1.00 per HP per month, standby charge.

METHOD OF EXCAVATION

Steel was provided in 18-inch runs and the longest steel used was 9 feet as this depth of hole was found to be the limit to which a narrow trench could be broken economically. Holes were drilled usually at about 18 inch centers and staggered. On deep cuts two lifts were taken and in this way overbreak was lessened.

Steel sharpening was all done locally and the average cost per bit was 12.5 cents. The standard cross bit was used and the angle of the cutting edge about 85°. Due to the hardness of the rock, which is porphyry and conglomerate, a bit will only drill about 18 inches before sharpening.

Blasting was performed by 2 gangs, each in charge of a blaster. All blasts had to be covered and for this purpose timber was used held by chains. The timber was from 4- to 8-inch in diameter and 16 foot long. Owing to the toughness of the rock, heavy charges of powder had to be used, averaging 2 to 2½ pounds in a 6 foot hole, and 5 to 8 holes were shot simultaneously with electric detonators.

Fortunately some of the deepest cuts were three or four hundred feet removed from houses. In these holes 3½ to 4½ pounds of powder were used and up to 15 holes were shot simultaneously.

COST

This rock work, including mucking, cost about $6.00 and as high as $9.00 per cubic yard in the deep cuts. The figures for this were based on a 4 foot wide trench and no allowance was made for overbreak. It must be remembered also that, this being a relief scheme, no labor saving machinery was used on the job. In mucking the rock sections some light tripods were made up of 2-inch pipe and chain blocks were used to hoist out large pieces of rock. Some pieces

as large as ¾ cubic yard were taken out in this way. In one cut, 300 feet long, the maximum depth in solid rock was 14 feet 6 inches. This cut was taken in two lifts with the exception of a few pop shots to level up the bottom. Mucking had to be done in four stages. The stages were placed on sprags put across the trench. The mucking cost of this section was very high, in the neighborhood of $2.30 per cubic yard. In the earth cuts not much difficulty was experienced in digging last winter. Very severe weather was the order for eight weeks, but we had a heavy snowfall. Although all streets were plowed, the ground was only frozen to a depth of about one foot; in some cases less where the snow was undisturbed. This made easy digging. We place all mains to one side of the center line and in this way they are protected somewhat from the extreme frost.

Early in the operation it was decided to backfill the same day as far as possible, as it was found that backfill left overnight would freeze as hard as concrete. In the rock sections, in order to get soft fill to pack around pipes, borrow pits were established. Sometimes this had to be hauled in trucks which, of course, added considerably to the cost. This fill cost about 85 cents per cubic yard and is put in for a depth of about one foot above the pipes. The rest of the trench is filled with the broken rock.

At one time it was feared that this rockfill would conduct the frost down to the pipes, but experience is leading us to disprove this hypothesis. Rockfill does not seem to freeze as badly as clay or loam. Tentatively, it would appear that the rock forms a series of air spaces and in a measure forms an insulator. It would be very interesting to have the experience of others who have to deal with the combination of rock excavation and extreme cold.

In spite of all this heavy blasting no serious accidents were incurred. One or two cases of hands and feet jammed while moving logs and a few windows were shattered by concussion. The total property damage was less than $50.00 which, I think, is a very low average, when it is considered that 4690 cubic yards of rock were removed, entailing the use of 8500 pounds of powder. The total lengths of trench on this job were

Main trench	7947 feet
Service trench	4243 feet
Total rock	4690 cu. yds.
Total earth	6662 cu. yds.

CHARACTER OF SYSTEM

Another feature of this job was the use of plain end Sandspun pipe and Dresser couplings. This worked out splendidly as all jointing was done by unskilled labor and absolutely no trouble has been experienced with leaks. In one place, due to poor work which escaped observation, it was found that two lengths of 12-inch watermain had sunk 10 inches, but no leakage was apparent on any joint. While using these couplings no effort was made to use plain end fittings as the cost was prohibitive, so that lead joints were used in all fittings.

In the house services one trench is used for two lots. In the past a single pipe for two houses was used with a "y" branch. Quite a number of complaints of noise in the pipes have occurred, particularly if there was a defective tap in one of the houses. Upon investigation it was found that two smaller pipes could be installed for very little more than the one large pipe plus special fittings. The decision to do this carried the added advantage from the electric thawing standpoint, as these two pipes are tapped into the same length of main, so that a perfect electrical connection is possible from one house to the other. This has amply proven advantageous this winter.

A practice has been established, that, so far as possible, a house service shall be tapped into every hydrant lead. This helps to maintain circulation in the hydrant lead and has been found to work out splendidly.

For service trenches, where the road had to be crossed, tunnelling was resorted to where the excavation was in earth. In some cases, even the main trench was tunnelled for short distances, the tunnel needing no false support even for heavy traffic. This is one instance where frost is a help. Another instance where the extreme frost was marshalled on our side was an excavation for a septic tank. One end of the excavation was in a lake which is filled with slimes. These slimes when wet have an angle of repose of about 5° being just like quicksand.

Building a coffer dam was going to be an expensive thing. After some reflection it was decided to see what the frost would do for us. The method adopted was to dig a trench about 6 or 8 inches deep around the wet end of the excavation and allow this to freeze and then come back and go down some more. This method allowed us to go down 6 feet without any difficulty at all and the rest of the work was performed inside the frozen walls and a considerable amount of expense was saved in this way.

The concrete work presented no great difficulties, the usual method being the use of calcium chloride solution in the mix. All aggregates were heated and live steam turned inside the tank for curing. In this way concrete was poured in 40° below weather.

(Presented before the Canadian Section meeting, March 29, 1935.)

FLUSHING OF WATER MAINS

By C. E. Brown

(Manager, Public Utilities Commission, Meaford, Ontario, Can.)

It is our practice to flush the mains over the entire town twice a year. This is supplemented by extra flushings when complaints are received regarding dirty water or bad taste. The complaint regarding dirty water is not common, and is usually caused by a very local and transitory condition.

Complaints regarding taste occur almost solely in the summer season, and are usually due to the fact that "there is too much chlorine" or that "there is a weedy or fishy taste" in the water. The majority of such complaints are from dead end mains, and an extra flushing at such points removes the trouble for the time being. It has been our experience that in such dead ends the so-called "chlorine" taste is much more evident than in the mains where the water is in constant flow.

There are two chief reasons or conditions that make flushing necessary: first, the deposit of sludge of a rusty nature, in various low spots or quiet points in the mains, where the ordinary rate of flow is not sufficient to keep the particles in suspension; second, the same condition in dead ends, where there is a minimum of flow, owing to non-circulation and to the very small number of users on most such lines.

The water in our system is obtained from the Georgian Bay, through an infiltration basin, and it is very seldom that any turbidity is in evidence in the intake water. It is chlorinated as it enters the pumps. Hence, deposits of sediment in the pipes are due mostly to chemical action, or from minute particles floating in the water, which are not perceptible except on close inspection. These no doubt settle down in quiet portions of the main and accumulate. Any causes that will stir up these deposits will result in dirty water. Among such causes are: the closing of valves, causing surges with scouring action and stirring up of deposits; the operation of hydrants for fire or other purposes; the extra draft caused by general use of lawn hose

in the summer. The latter type is of only a transitory nature, however, and will usually be rectified by the very action that causes it.

Sometimes we get local rusty water for which there seems no adequate explanation, than that accumulated deposits have broken loose. This condition clears up as a rule if taps are run freely, but if it does not remedy the condition, it is necessary to flush the hydrants on that line.

THE TRANSPORTING VELOCITY OF WATER

In order to clean out a water main by flushing, it will be clear to anyone that the velocity that may be attained is the vital factor in getting rid of deposits.

At low velocities, the solids, whether present in great quantity or extremely distributed through the water, will be rolled or dragged along the bottom of the pipe. By increasing the velocity, these particles will be picked up and carried along in the water. The velocity at which the particles become suspended depends upon their size and weight, or putting the point a little more technically, the diameter of each particle varies as the sixth power of the velocity. These are theoretical considerations, and actual experiments show that, due to other considerations, diameters do not vary quite as rapidly as the square of the velocity. However, it is apparent that any increase in velocity causes a very much more than proportional transporting capacity.

Hydraulic engineers state that the velocity at which the material becomes all suspended, is the one at which the minimum loss of head occurs. After the speed is attained, the percentage of solid matter that can be transported is independent of the velocity. Considering the specific gravity of sand for instance, we find that when immersed in water, it is only half its weight in air. Therefore, the frictional resistance due to its motion is slight, and this helps to explain why the deposits in mains are so easily carried by currents of only moderate velocity.

SCOURING ACTION

Scouring action in a pipe is an inverse function of the diameter. Because it may be found that a certain velocity in a given sized pipe will move the deposited material, this is no indication of what may be expected of currents of the same velocity in pipes of other diameter. For example, experiments with sand of size varying from 0.16 to

0.75 mm. for 1-inch pipe show that the velocity of suspension is about 3.5 feet per second, for 3-inch pipe about 4 and for 32-inch pipe about 9 feet per second.

This is because the velocity at the center of the pipe is much greater than that at the circumference due to friction and viscosity. The movement of the water through a pipe is also resisted by the adhesion of water to the pipe and by the viscosity of the adjacent layers of water, with the result that a sliding action takes place which is aptly described by Lionel S. Marks as telescopic; the central core moving fastest (at about twice the mean velocity) and the outermost layers moving comparatively slowly. The difference in speed caused by the foregoing conditions is the more noticeable the larger the pipe. Hence the mean velocity necessary for scouring and transporting is greater in larger pipes than in smaller ones.

CRITICAL VELOCITY

There is a certain critical velocity at which neither scouring nor deposit takes place. Above the critical velocity scouring occurs, while below it, silting takes place. The minimum mean velocity required to prevent the deposit of silt is from 2 to 3.5 feet per second. Sand will be disturbed if the mean velocity exceeds 3 feet per second.

It must be remembered that these are mean velocities, and that the actual circumferential velocities, as stated before, are something less than this. Three feet per second is commonly taken as the minimum speed for transporting heavy sand and silt. However, in order to flush a main thoroughly, it is considered that a velocity of 6 feet per second is necessary, in order not only to transport the deposits but to give the water the necessary scouring action on the inside surface of the pipe.

In a 4-inch pipe a velocity of 6 feet per sec. requires a flow of about 200 imperial gallons per min. For larger pipes the figures are shown below:

Size, inches	*Imperial gallons per minute*
6	440
8	780
10	1150
12	1650
16	3100

The flow obtained from a hydrant may be conservatively estimated at 1000 imperial gallons per min. Therefore, it is not considered

that sufficient current for flushing can be obtained in a main over 12 inches in diameter, unless more than one hydrant can be used at the same time.

When proceeding to flush the mains systematically on a system, it is advisable to start at the hydrants nearest to the source of supply and work outwards, so that when those furthest away are opened, the dirty water will not be carried in from the more central districts.

In a dead-end line with no feed-ins from the side, the case is simple, and it is usually easy to get a good flushing current in such a pipe.

However, in a net work where one or more laterals feed in, in order to get the full effect in each pipe, it is necessary to manipulate the valves in order to confine the flushing current to one pipe only, if at all possible. When through with these operations, it is important to see that all valves are left in their original, open or closed positions.

During the flushing of a hydrant, both caps should be removed in order to get as full and free a flow as possible. Sometimes, however, local conditions exist that prevent one side from being opened.

During the flushing operation, there is invariably an initial flow—of short duration—of very murky water from the hydrant tee, followed by a longer period of more or less dirty water, depending on the condition of the main. It also frequently happens that the flow of dirty water clears up for a few seconds and then becomes dirty again. This process may be repeated before the water becomes permanently clear. This may be due to the breaking away of deposits which have withstood the erosive action of the water for a while and finally capitulated, or it might be caused by flow from laterals that have not been closed off.

Sometimes after the water clears up, if the hydrant is closed and then opened again, another rush of dirty water will be observed. Apparently the surge caused by the closing and opening of the hydrant, will stir up the remaining deposits of sediment in the pipe.

(*Presented before the Canadian Section meeting, March 27, 1935.*)

FLUSHING OF WATER MAINS

By C. G. R. Armstrong

(Consulting Engineer, Windsor, Ontario, Can.)

This is a subject on which little has been written. Probably the title itself signifies its simplicity, and, hence, heretofore, few have deemed it of sufficient importance to have a place in our discussions. Yet I venture the opinion that many waterworks men here assembled can relate some interesting incidents which have happened along the lines of this subject, while they have been engaged in the pursuit of their official duties. If this paper in some small way may be the means of bringing to light some of these experiences, I shall deem it to have been worth the effort.

The various deposits which lessen the carrying capacity of water mains may be classified under the following heads:

1. Incrustations which form on the inside of water pipes and are commonly known as tuberculation. These form more readily on unprotected or imperfectly protected surfaces.
2. Deposits or growths on the inner surface of iron pipes, whether this surface is protected or unprotected, the nature of these deposits depending upon the chemical or biological composition of the water.
3. Accumulation of débris and mud in the inverts, hollows and dead ends of the mains.

Of the three above classified deposits, the only case in which "flushing" is really effective is in the last case, and sometimes in this one where the deposit is hard and has become cemented, some mechanical means may have to be resorted to, as in the first two classifications. It does not depend so much on the reduction of the diameter in the pipe, as on the roughness of the interior surface, which roughness increases the friction to such an extent that the carrying capacity is affected.

The main object to be attained in the flushing of watermains is to keep the main clear and improve the taste, color and quality of the water. If sediment is allowed to accumulate in the pipes, as a rule, it first makes its appearance at a dead ended main, that is, a main fed from one end only. If these are neglected, this accumulation

backs up the pipe, and as time goes on, a larger part of the system is affected. On account of there not being enough flow at the dead ends of mains, it is necessary to resort to more frequent flushing. When mains are flushed in the business district of cities and town, care must be exercised not to cause undue flooding on pavement surfaces, or to overtax the capacities of the sewers. Often hose connections are made leading from a hydrant to the manhole or catch basins, to eliminate water running on the street surface.

Mains should be flushed when consumption is at a minimum, or at least, care should be taken so as not to create the Hydro peak, for it seems to be the general practice in this work for a man to get the most water through the main in the shortest time, without reducing the pressure to zero. The flushing should be carried on from the clear to the dirty pipes, that is, from the source of supply toward the end of the system. Service pipes should not be used, while flushing is in progress.

The local conditions existing in the municipalities are the prompting factors in this subject. Each individual superintendent has his own ideas on how the flushing of mains should be carried out, and while these ideas may differ, the net results desired and obtained in each case are quite similar.

In the municipalities in Essex and Kent Counties, where the source of supply comes either from deep wells, Lake St. Clair, Detroit River or Lake Erie, the subject of main flushing probably receives less attention than in many other Ontario centers. This, no doubt, is due to the fact that much of the water used from the Lake and River supplies in this area, is now treated and filtered at some of the most modern filter plants.

This was not always the case. For in one town, where we are Engineers, the waterworks superintendent has been there for over thirty years, and he has often related to me some of his experiences in flushing water mains. They have a modern filter plant now in operation for 15 years, yet only a year before its opening firemen were called to a fire near the dead end of a watermain. Upon attaching the fire hose and opening a hydrant, the men were unable to get the water through the hose nozzle until they had removed the same and allowed the mud to be flushed out of the main. Yet then they flushed the watermains once per month. Now this operation is only performed, generally, twice a year. On another occasion a dead water lizard was flushed out through the hydrant nozzle. After the flushing in the fall, a quart mixture, half and half of machine oil and kerosene

oil, is placed in the hydrant by means of a funnel and a piece of rubber hose, the mixture being allowed to run down the hydrant spindle. This is quite an effective means against freezing and sticking, which often takes place in hydrants during the cold weather.

I went into a near-by Border Town, early in the month of January, and collected some water samples from the flushing of dead end mains. I had a test made for turbidity on these samples, for that is the determining factor most superintendents use in determining when a main has been sufficiently flushed. The superintendent in this town is in the habit of flushing the watermains four times a year, namely, in March, June, August and November.

We first took a sample of raw water, and then a sample of the filtered water. The tests showed a turbidity of 10 to 15 p.p.m. in the raw water, and 1 p.p.m. in the filtered water. I understand the yearly average for this raw water is about 50 p.p.m.

We then went to a dead end main, that had been laid about seven years, on which the nearest house to the end of the main was about 1500 feet. Upon opening the hydrant at this point, the water that came out for the first few seconds was quite clear, then brownish, having a clay appearance after settlement, the turbidity measurement of which was 500 p.p.m. After a 10 minute run, the turbidity had fallen to 300 p.p.m.

We next proceeded to a hydrant on a dead end main, that had been inadvertently missed, in the November flushing operations. Upon opening this hydrant the water discharged in the first few seconds was quite clear, as in the other case. At the end of the first minute the turbidity had increased to 800 p.p.m., and had a rusty brown color, with the appearance of rust flakes. At the end of about 4 or 5 minutes, the rusty brown color was less perceptible and the turbidity had fallen to 500 p.p.m. Immediately after this, or about 6 minutes after opening the hydrant, a dense, silt-like color, appeared which upon allowing to settle had a gray, fluffy appearance. The Turbidity had increased to 20,000 p.p.m. At the end of 15 minutes the silt-like color was still very much in evidence, but, upon settlement, the fluffy appearance had disappeared. The sediment was much firmer, the Turbidity had now dropped to 10,000 p.p.m., and it was a question of time, as to when the flushing would clear up the water.

I mention this experience to show the importance of systematic and frequent flushing of watermains. Each Municipality may have local conditions which govern the policy to be followed.

(*Presented before the Canadian Section meeting, March 27, 1935.*)

SYNURA TROUBLES AT ALBANY, NEW YORK

By George E. Willcomb

(Supervising Chemist, Water and Sewage Treatment Works, Albany, N. Y.)

This paper is an account of the sudden appearance of the protozoon Synura under the ice of Alcove Reservoir, a 13 billion impounded main source of supply of the new Hannacroix Creek system of the City of Albany, placed in operation in 1932. It is essentially a recital of the emergency measures successively brought into play by a modernly equipped plant to combat a surprise attack by one of the most potent odor producing organisms.

Synura are members of the protozoa group, the lowest form of animal life. The colonies move with a brisk rolling motion and the diameter of a cluster is approximately 0.5 m.m. Synura appear in the local reservoir about the first of June and exist at concentrations of about 100 standard units per c.c. throughout the summer and fall. The colonies are uniformly distributed from top to bottom of the reservoir. This renders their control by copper sulphate difficult and necessitates the application of five tons of chemical. This is handled in a speed-boat and requires two days for the operation.

During the past two years no attempts have been made to control the algal growths in the main body of the reservoir. The shallow bays only have been directly treated with copper by means of a boat. The successive cycles of diatoms, chlorophyceae, cyanophyceae and protozoa in the main basin have been allowed to proceed without molestation. On several occasions the blue green Anabaena have reached a concentration of 10,000 standard units per c.c. without the slightest taste or odor being noted in the final plant effluent.

The organisms leaving the reservoir have been controlled by a continuous application of copper sulphate solution directly into the mouth of the 48-inch cast iron conduit leading from the dam to the filter plant, a distance of 10 miles. It requires from 5 to 8 hours for the water to reach the plant and enough copper is added to assure a thorough disintegration of the cells. The concentration of copper

ranges from 0.25 to 0.45 p.p.m. The theory is that the decomposition products are volatile and can be easily removed by efficient aeration. This is true for most algal forms, but there is good reason to believe that the decomposition products of some protozoa like Synura approach the state of a true solution more or less resistant to volatilization by aeration.

The aerators at the local plant consist of headers of bronze nozzles under a controlled head of 100 feet. The jets are automatically adjusted by a float-valve to a maximum height of 25 feet. The aerator is inclosed and the chamber mechanically ventilated and heated so that all-year operation is feasible. By means of the copper treatment followed by aeration at no time since the plant was placed in operation in December 1932 has there been an algal taste or odor in the city mains even during the period of high concentration of the summer months. Efficient as this process was against the ordinary run of organisms, subsequent events proved its vulnerability to certain forms of protozoa.

During the fall of 1934 the water was being withdrawn from the outlet 45 feet below the surface of Alcove Reservoir. The application of copper sulphate at the dam had been discontinued October 4, as being unnecessary. No Synura had been found in the daily samples up to December 5, but a great deal of trouble had been experienced from short filter runs caused by increasing numbers of the diatom Melosira. To combat the diatoms the copper sulphate treatment at the dam had been begun again on December 6, but had to be discontinued on the 8th. due to the freezing of the copper solution. On December 5, Synura appeared in the plant influent at a concentration of 10 standard units per c.c. and no attention was paid. On December 14, water works officials were surprised to receive a complaint from a consumer concerning a fishy taste in the tap water. Other complaints followed in rapid succession and on December 22, the characteristic bitter cucumber odor was noted and the trouble definitely ascribed to Synura.

Four remedial measures were at hand to combat the organism and its resulting taste and odor:—

(a) Adequate copper treatment of the water leaving the reservoir.
(b) Aeration.
(c) Application of activated carbon.
(d) Pre-chlorination.

A canvas shelter, electrically heated, was quickly erected inside

Alcove Gate House so that the copper treatment of the water leaving the reservoir could be resumed. This was completed December 22, and at the same time the aerators were adjusted to give a maximum height of spray. Consideration was given to the actual treatment of the reservoir by means of dissolving copper sulphate in bags introduced through holes in the ice. But on account of the labor involved it was decided to leave this as a last resort.

ACTIVATED CARBON

Coincident with the starting up of the copper treatment at the dam activated carbon was introduced into the aerator influent. This was the only means at hand at the time for handling carbon. It was fed by means of a W & T machine into an injector and introduced against the dam pressure into the aerator influent. The alum was next introduced and the carbon particles acted as a nuclei for a much improved and quick settling floc. The copper sulphate solution was increased to 0.45 p.p.m. Aeration was adjusted to maximum height and 0.8 grain per gallon (the highest carbon possible) carbon was introduced into the aerator influent. This cut the odor down 75 percent but the final treated effluent had a threshold concentration of Cucumber-4 which was much too high.

Inasmuch as for two years the city tap water had been without odor, nothing but 100 percent reduction in odor would be tolerated by the consumers, for it had been demonstrated that they would register complaints at thresholds of 2 and 4. In the following all odor intensities refer to the threshold point and were determined by the air dilution and water dilution methods. High threshold values of the raw water were obtained by the air dilution method by means of the Fair-Wells Osmoscope. This instrument was of great value in the routine odor determinations.

From the results obtained with a five-day run with carbon applied to the aerator influent (raw water) and with threshold odors of Cucumber-32 in the raw water, it was apparent that this method would not do. Applying 0.8 grain per gallon carbon only brought the odor of the effluent down to Cucumber-2 at the best. It was evident that some experimentation must be done to ascertain the optimum point of application of the carbon. As designed, the aerator influent had the only carbon connection piping. It was decided to install piping to feed carbon at the following points:

(a) Carbon introduced into each filter influent valve and thus run continuously into the water on top of the sand.

(b) Heavy dose of carbon applied to individual filter influents for one hour following a wash and then discontinued for the remainder of the run.

(c) Intermittent doses of carbon applied to individual filter influents for successive 45 minute intervals during filter runs.

(d) Carbon applied continuously to basin effluent weirs thus increasing the time of contact of water with carbon before carbon is deposited on surface of sand.

TABLE 1

Results of application of carbon at different points

("C" is an abbreviation for cucumber odor)

POINT OF APPLICATION OF CARBON	CARBON	THRESHOLD ODOR		PALATABILITY OF EFFLUENT	REMARKS
		Raw	Effluent		
	g.p.g.				
Continuously to individual filter inlet valves	0.4	C-16	C-4	Poor	Contact of water with fresh carbon too short to reduce odor effectively
Total dose of carbon applied to individual filter inlet valves for one hour following wash and then discontinued	0.4	C-16	C-0 at start of run; C-4 at end of run	Poor	Carbon reduced in efficiency by becoming coalesced with alum floc. Compacted carbon and alum floc on sand surface less efficient than colloidal suspension of carbon in basin effluent
Intermittently to individual filter inlet valves every 45 minutes	0.4	C-8 to C-16	C-2 to C-4	Poor	Difficult to apportion carbon application so as to get required amounts of carbon on individual beds. Insufficient contact period of fresh carbon with basin effluent
Continuously to basin effluent	0.2	C-8	C-2	Poor	By adding carbon to basin effluent valves, maximum contact of colloidal carbon with filter applied water is obtained. Maximum odor removal with minimum amounts of carbon
	0.3	C-32	C-2	Poor	
	0.4	C-64	C-0	Excellent	

The results obtained by the different methods of carbon application are given in table 1. Under the heading "Palatability" the fact is recorded whether the final treated water had an agreeable taste or not, for it is a unique characteristic of Synura to impart a bitter metallic after taste to a treated water even though such a water may have had no apparent taste or odor at the time of testing.

PRECHLORINATION

From published accounts from various places prechlorination had been of decided advantage in controlling the taste and odors produced by Synura. The experience of New York City indicated that a chlorine dose of from 0.3 to 1.0 p.p.m. would be effective in controlling the organism.

Prechlorination apparatus has always been available at the local plant for emergency purposes. It is not used regularly as the final automatic chlorinators furnish the only chlorine necessary for routine plant output. The emergency pre-chlorinators treat the aerator

TABLE 2

Results obtained from pre-treating raw water with varying doses of chlorine

RUN	ODOR RANGE		CHLORINE APPLIED—PARTS PER MILLION					CARBON APPLICATION	REMARKS
	Raw	Filtered	Dose	Mixer: Influent	Mixer: Effluent	Basin, effluent	Filter, effluent		
1	C-32	C-4	1.6	1.3	1.3	0.7	0.1	0.6 grain per gallon to influent second mixer	Chlorine derivative taste in effluent
2	C-32	C-4	0.9	0.7	0.4	0.2	0.02	0.2 grain per gallon to basin effluent	Final odor too high
3	C-32	C-2	0.8	0.7	0.4	0.2	0.02	0.2 grain per gallon to basin effluent	Final odor too high
4	C-70 C-10	C-4 C-2	1.2	0.9	0.7	0.3	0.04	0.2 grain per gallon to aerator influent; 0.2 grain per gallon to basin effluent	Final odor too high
5	C-10	C-4	1.0	0.9	0.6	0.3	0.06	0.3 grain per gallon to individual filter influents	Final odor too high

effluent just as it enters the first pass of the mixing or conditioning process.

As soon as the cucumber odor became well established the prechlorination process was started and in all, five experimental plant runs, of several days duration each, were made. Pre-chlorination was handicapped in that the capacity of the machines allowed only a maximum dose of 1.6 p.p.m. to be used.

The results of runs with pre-chlorination are given in table 2.

From the results obtained from the various runs with pre-chlorination it was evident that with the concentration of chlorine used, little benefit had been derived in odor removal. To ascertain whether

higher doses of chlorine might be more effective, experiments were made in the laboratory using much higher amounts of chlorine and dechlorinating with sodium thiosulphate.

An experimental run was made with a raw water with a threshold odor of Cucumber-16. The water was treated with an hypo-chlorite solution giving a concentration of 3.0 p.p.m. available chlorine to the water. This was allowed to stand for one hour, at the end of which time the chlorine excess had fallen to 1.25 p.p.m. The odor of this treated water was Chlorine Cucumber-4. The residual excess was next treated with 0.3 grain per gallon of sodium thiosulphate solution bringing the excess down to 0.05 p.p.m. This de-chlorinated water had an odor of Cucumber-0, but there was an unpleasant after medicated taste in the water.

It is probable that had this heavy pre-chlorination been actually applied at Alcove Dam and the chlorinated water passed through the plant aerator, then the subsequent filtration in conjunction with carbon treatment would have produced a tasteless water but the cost of such treatment would have been prohibitive. Carbon alone, applied at the optimum point in the treatment process, has been proven to be the more economical procedure.

CONCLUSIONS

Tastes and odors produced by Synura are difficult to handle on account of the after effects. Even though at the time of testing the water may be free of apparent taste or odor, yet to a consumer drinking the water from the mains this same water may be quite unpalatable due to a dry metallic sensation on the tongue.

Tastes and odors brought about by the decomposition of Synura cannot be eliminated by aeration alone. Local experience would indicate that even with the most efficient type of aeration under winter conditions the reduction in odor at best is only 50 percent.

Continuous copper sulphate preceding aeration for an adequate period, say five hours, decomposes the cell material and renders it more responsive to aeration and coagulation, resulting ordinarily in a 100 percent increase in the length of filter runs.

Activated carbon when properly applied in conjunction with filtration will reduce the odor of a raw water of Threshold concentration-64 to zero and produce a palatable effluent.

Thorough mixing of the carbon is necessary and local experience emphasizes the desirability of a long contact period of the colloidal

suspension of carbon with the water to be treated. For this reason the point of discharge of the settling basins has outstanding advantages if the retention period between basins and filters is adequate. Carbon applied in this fashion reduces the runs of normally operated filters not more than 25 percent with doses under 0.5 grain per gallon.

The coalescing action of chemical precipitants followed by the deposition of floc and carbon on the surface of the sand reduces the efficiency of the latter. For this reason the application of carbon to basin influents or directly into individual filter influents is not as effective as prolonged treatment of the clarified water, except in cases where flocculation is improved or basin sludge rendered more stable.

The decomposition products of Synura may be eliminated by adequate pre-chlorination followed by de-chlorination. Local experience indicates that high doses of chlorine are necessary, approximately 3.0 p.p.m., and that the tendency is to produce a medicated taste in the final dechlorinated water. Secondary aeration is of benefit in such a case.

Albany's experience indicates that carbon treatment alone is the more economical remedial measure.

(*Presented before the New York Section meeting, March 21, 1935.*)

LOW WATER TROUBLES AT QUINCY, ILLINOIS

By W. R. Gelston

(Superintendent, Water Works Commission, Quincy, Ill.)

The February, 1935, issue of the Journal of the American Water Works Association contains four very interesting papers on rainfall deficiency and drouth conditions in the upper Mississippi river basin. It may be of interest to show the effect of this rainfall deficiency upon the stage of the Mississippi river and the Quincy water supply.

The Quincy gauge, which is located about thirty miles below the mouth of the Des Moines river, reflects rainfall and run-off conditions on about three-fourths of the area of Iowa, a considerable portion of Minnesota, Wisconsin and northern Illinois.

The Quincy Water Department river stage records date back to 1875, but they were not complete until about 1880. When the low water records at Quincy are under consideration, those records in the winter months should be regarded with suspicion. The Burlington Railroad bridge is just a mile upstream from the Water Works gauge and ice gorges against the bridge piers undoubtedly produce fictitious low stages on the gauge. When the high water stages of recent years are being compared with those of the 1880's and 1890's it is evident that the high water marks have been affected by the construction of the levees which confine the river to narrower limits and produce higher stages.

The highest stage recorded between 1880 and 1902 was in May, 1888, when it reached 19.4 feet. This high of 19.4 in 1888 has been exceeded only twice. In June, 1903, the recorded high was 20.2 feet and in April, 1929, the water rose to elevation 21.4 feet. Going back into ancient history, however, there is a cut stone high water mark which is set in the concrete foundation of the pumping station. This stone is marked "High water June 5, 1851." The elevation of this mark is 22.2 feet on the present gauge.

IOWA RAINFALL RECORDS

Mavis and Howe[1] in their paper "Unusual Precipitation Records" state that the year 1881 was the wettest calendar year on record in Iowa and that 1910 was the driest calendar year. The rainfall in 1881 was sufficient to cover the entire area of the State of Iowa to an average depth of 44.2 inches. The 1910 rainfall would have covered it only to a depth of 19.9 inches. Unfortunately, the Mavis and Howe paper included data only to May 31, 1934. They report a precipitation of 19.5 inches for the year ending May 31, 1934. The calendar year 1934 probably shows even less precipitation.

While this paper is concerned chiefly with low water stages it may be of interest to note the effect of the heavy precipitation of 1881 on the river stages at Quincy. Normally the river at Quincy reaches its highest annual stage in April, May or June with a considerable drop during July and August, followed by a secondary rise as a result of autumn rains. The year 1881 started with a normal stage in January, rising to a peak of 16.9 feet in April. This was followed by a decline to 13.4 feet in June and then by a rise which reached a maximum of 18.7 feet in October. The river continued abnormally high throughout November and December of 1881 and through January, 1882. The average stage for the year 1881 was 10.85 feet. The average stage for the year 1903, which was another rainy year, was 9.42 feet and for 1929, the last year of heavy precipitation, it was 7.5 feet.

LOW WATER

Since January 1, 1880, there have been 508 days on which the river at Quincy was below the low water mark. Of that number 194 occurred in winter months when they were probably due, many of them, to ice gorges. From January 1, 1880, to March 1, 1891, there were forty below-zero stages, all of which occurred in November, December, January and February. The year 1891 seems to have been a very dry year. In that year there were twelve minus days in September, twelve in October, three in November and two in December, a total of twenty-nine in the latter part of the year. There was a total of ninety-five minus days in the first twenty years of records and 1891 was the only year in which minus stages were registered in the summer months. The first ten years of the present

[1] JOURNAL, February, 1935.

century show only one day of minus stage and that was in January, 1908.

Then in 1910, the driest year on record in Iowa, at least until 1934, there were fifteen minus days in August, one in November and twenty-four in December, or forty in the year. The average river stage for the year 1910, was 3.8 feet above low water mark. Beginning with the year 1911, to and including the year 1930, there were forty-three days showing minus stages. All of these lows, except five, were in the winter months. They were the four minus days in July, 1911, and one in September, 1925. This twenty-year period was comparatively free from minus stages, but was followed in 1931 with forty-one days with the river at a minus stage, only two less than for the preceding twenty years, and thirty-seven of these were in August and September. There were twenty-six minus days in 1932, with fifteen in October, two in November and nine in December. The first minus stage reached in 1933 was on August 21 and for fourteen months, thereafter, the recording of plus stages was the exception rather than the rule. The last three days of September and the first day of October were plus. This four day plus period was followed by eighty-eight successive days of minus stages. A minus of 1.5 feet was recorded in September; 1.1 feet in October, and 1.8 feet in November and 3.0 feet in December, when the ice produced a fictitious low. There were forty-five minus days distributed through the first five months of 1934, with a minimum of three in April and May and a maximum of eighteen days in January. There were twenty-nine minus days in June, eleven in July, thirty-one in August, twenty in September and one in October, 1934. Since October 1, 1934, there have been no minus stages. There were 263 days beginning with August 21, 1933, and ending with October 1, 1934, which showed minus stages. This means that the river was below low water mark 65 percent of the time during that period of 13½ months, and that 52 percent of all minus stages recorded in the last fifty-five years, occurred in that same 13½ months. Included in this period were five successive months in which the average monthly stage reached from 0.5 to 1.2 feet below. The average stage for the year ending August 31, 1934, was only 0.2 of a foot above low water mark. The average stage for the dry year, 1910, was 3.8 feet above low water mark.

QUINCY INTAKE TROUBLES

The Quincy intake equipment consists of an intake well and two intake pipes, through which the water flows by gravity into the well. The three low lift centrifugal pumps have individual suction pipes extending into the bottom of the intake well. Vacuum pumps are used for priming the pumps which stand on a floor at elevation fourteen feet above low water mark.

The intake well, which was built in 1887, is a brick structure set in the ground between the pumping station and the river. The brick walls were laid in cement mortar and the well is 15 feet in diameter. The walls rest on solid rock which is at an elevation about four feet below low water mark. The bottom of the well was originally made water tight by a false floor of hard brick laid in cement mortar on top of the solid rock. The 30-inch wooden stave intake pipe was laid into the well above this brick floor when the well was built, and a 36-inch cast iron intake pipe was laid into the well in 1914. The old 30-inch pipe cannot be depended upon for regular service because the river end is buried under a sand bar most of the time. The bottom of the 36-inch pipe is only 3.5 feet below low water mark. When the river reached a stage of 1.4 feet below low water mark, in September, 1931, there was a depth of water on the bottom of the intake pipe of only 2.1 feet. With the pumps running, this level was pulled down considerably and the full flow of 2.1 feet of water could not be secured. The top of this intake pipe, out in the river, is at elevation 10 feet below low water mark. When this low stage was reached the pull-down in the well was sufficient to permit air to be drawn into the pumps and when air accumulates in a centrifugal pump, the suction is lost.

Two solutions for this problem were obvious. The rate of pumping could be cut down, or the pump suction could be extended deeper into the well. Since there was a possibility that the river might go even lower, the extension of the suction pipe was decided upon. A portable air compressor and paving breaker were put into operation breaking out a depression under the suction pipes. The brick floor and considerable solid rock were broken out. At any rate, sufficient depth was secured for 16-inch extension pieces on the suction pipe and this brought the open ends of the pipe 4.34 feet below low water mark. This emergency operation again proved the great value of a large reservoir, full of pure water, out on a high hill. The reservoir was

filled before administering the anesthetic and the operation was successful. This operation, however, provided only temporary relief.

When the river got down to a new low of 1.5 feet below in September, 1933, the Quincy Water Department, especially the pumping station engineer and the superintendent, began to realize that river depressions might be as serious as financial depressions for our folks. An appeal was made to the Board of Water Commissioners for permission to uncover the 36-inch pipe at the well, break out the rock under it, and lower it at least 2 or 3 feet. The commissioners considered the expense involved in this plan, unjustifiable. In fact, one of the commissioners, discussing the matter, used the old California alibi "it never happened before" so why any protection against such an emergency now? But the decision of the commissioners did not remove that panicky feeling from the breasts of the engineer and superintendent.

By the middle of December, 1933, when ice increased the trouble, the stage was around two feet below low water mark and the pump discharge had to be reduced and one or more filters taken out of service. Early in the morning of December 26 the stage was 3.2 feet below low water mark. Only two of the six filters could be operated and even at this low rate of operation, the pump lost its suction several times because of air. Fortunately there was a rise that day and the next day and on the 28th the plant was operating at the normal rate again, but on January 2, the river was at minus 2.8 feet again and it was evident that something should be done. In the meantime, Engineer Brinkoetter had suggested siphoning water over the hump in the intake pipe and without consulting the water commissioners this time, the installation of a siphon was begun.

The air compressor and paving breaker worked on the bottom of the well, breaking out rock. A local steel construction company made a 36-inch 90 degree ell with a 36-inch flange on one end and the other end was made long enough to reach about five feet below low water mark. Fortunately there was a 36-inch flanged gate valve attached to the well end of the intake pipe and the steel ell was bolted to the valve and a 1-inch pipe connection was made between the top of the ell and the suction pipe of the pump. By means of this connection the siphon and the pump were primed at the same time by the same vacuum pump. While this installation was not made in time to be used while the river was at its lowest stage, it did prove its

efficiency and value in August and September, 1934, when the consumption of water was excessive on account of the hot dry season.

There were ten successive days the latter part of August and the first part of September when the river stages were from 2.2 to 2.7 feet below. During this period the plant was operating at full capacity and with no intake trouble whatever.

It is possible that siphons have been used in this manner and for the same purpose before. If so, the knowledge of such use cannot be very widespread. This account of the Quincy trouble has been written with the hope that the siphon idea may help other water works men who may be face to face with similar conditions.

(*Presented before the Illinois Section meeting, April 11, 1935.*)

LEGAL ASPECTS OF A LARGE ARTIFICIAL LAKE WATER SUPPLY PROJECT

By Clayton J. Barber

(Special Counsel for City of Springfield, Ill.)

The courts of Illinois, for almost a century, have uniformly held that the providing of a pure and wholesome water supply is one of the most important functions of municipal government. With this judicial recognition of the public nature of the problem, it is not surprising to find that of all the public water supplies in Illinois, more than 80 percent in number, and over 96 percent in volume of water furnished, are publicly owned and controlled.

While great progress has been made in the art of water treatment and purification, the ordinary sources of supply, such as wells and channel dams, have proven inadequate to serve the demands of an ever increasing population and per capita consumption. The most abiding and satisfactory solution of the problem is believed by many to be found in the construction of a large artificial lake or reservoir. Its acquisition and most efficient management, protection and control present many interesting legal problems. To aid in the solution of some of the more important ones, the City of Springfield found it necessary to procure the passage by the General Assembly of three different acts.

RAISING OF FUNDS

Procuring the necessary money is, of course, at the threshold of the project. This may be done in either or both of two ways: (1) by directly pledging the credit of the municipality, supported by its taxing power; and (2) by issuing water revenue bonds, which are not direct obligations of the municipality, but are solely charges against and payable from the earnings of its waterworks system.

Prior to 1929, the debt incurring power of an Illinois city or village under 300,000 in population, was strictly limited to 2½ percent of the value of the taxable property. In that year Springfield procured the adoption of an amendment permitting any city or village to incur

2½ percent additional indebtedness (making a total of 5 percent) "for the construction of impounding dams and artificial lakes for water supply purposes, together with lands and equipment necessary and incidental thereto." Under this amendment a city or village which has already reached its normal debt incurring limit of 2½ percent, may, upon an appropriate petition and favorable vote of its electors, issue bonds to the amount of an additional 2½ percent of its taxable property, for the purpose of acquiring the necessary land and constructing an artificial lake and facilities for using the water in its distribution system. Such bonds are supported by the taxing power, although, of course, provision may be made (as was done by Springfield) for the omission of the tax levy in each year in which all interest and principal maturities of the bonds are paid from earnings of the waterworks.

But even without calling upon the voters of a city to approve the incurring of additional indebtedness or the issuing of direct obligation bonds, an Illinois city or village may, under the provisions of another Act adopted by the General Assembly in 1929, construct a waterworks system or make additions or extensions thereto (such as an artificial lake, with the necessary equipment for availing of the use of its waters), by issuing water revenue bonds, payable solely out of the earnings of the waterworks system. Such water revenue bonds are not obligations of the municipality within the meaning of any statutory or constitutional limitation upon indebtedness, and, if supported by a showing of adequate present or prospective earnings, command as good, if not a better, market price than direct obligation bonds. Such Water Revenue Bonds are the basis of most of the loans made to Illinois cities by the Federal Emergency Administration of Public Works.

ACQUISITION OF LAND

With the necessary financing arranged, we must next deal with problems relating to the amount of land to be taken (including particularly the amount of marginal land to be acquired in order to protect the reservoir from pollution and erosion), necessary highway and railway changes, the acquiring of land to be used incidentally (such as for switch tracks to serve pumping and power plant), and the right to take land already devoted to other public uses—such as school sites.

The only statutory authority for condemning the land is contained

in the Waterworks Act authorizing any city or village to go beyond its corporate limits and acquire, by purchase or condemnation, "all necessary real estate for the location, erection, construction and maintaining of waterworks." Under this language the courts have held that the city or village authorities may anticipate the future public needs and determine for themselves the amount of land to be taken, provided the land sought may be helpful to the project, upon some plausible theory. Thus, Springfield was sustained by the courts in each case in taking a comparatively wide zone of land above the flood line, on the theory that it would afford protection from pollution, erosion and silting, by excluding undesirable occupany or use and allowing the planting and growth of trees and other protective vegetation.

Since it is obvious that any lake will be the better protected by controlling the entire watershed, the amount of land to be taken ceases to be a legal problem and becomes a practical question of economics to be determined by the City as to how much land it can afford to buy.

The highway authorities in the four affected townships were found to be coöperative in vacating and changing many miles of highways, all at the City's expense. But a new legislative Act was required to enable the State Highway Department to change the location of an important state road about to be flooded.

Although its right was challenged, the City was successful in taking land for a switch track, to be used in conveying building material for the improvements, and fuel and supplies to the new waterworks and power plant.

The City's right to take land already devoted exclusively to public use as a school site being very doubtful, the introduction before the General Assembly of a bill authorizing the condemnation of school sites under like circumstances, was sufficient to induce the school authorities to accept the City's offer and to coöperate in procuring a favorable vote to sell the site and relocate the school elsewhere.

PROTECTION OF SHORE LINE

The use to be made of the zone of land varying in width from about 300 feet to three-quarters of a mile and surrounding the lake presented more novel, if not more interesting questions. Private ownership of this shoreland would obviously frustrate adequate lake protection, thwart any comprehensive plan of improvement, and, in

large measure, prevent the development of recreational values. Since the proper improvement and use of this shoreland afford not only the lake's protection from pollution and erosion, but determine in large part its beauty and recreational worth, its proper control and development becomes one of the most important problems of the lake project.

In Springfield's case, it was believed that the shore land, being far in excess of the recreational needs of the general public, could best serve the lake project by being in part used and improved as home sites by persons interested in beautifying the premises and protecting the lake. Being without power to resell the real estate without first passing an ordinance declaring (contrary to the true facts) that the land was no longer needed for any public purpose, and offering it at public auction, the City, therefore, procured the passage of another Act of the legislature permitting the making of leases to persons of good reputation and character, with the right to such lessees to construct and occupy dwellings approved by the City, and for such rental and with such powers and duties as the City should determine. The period was limited to 60 years because any law attempting to authorize a period beyond the possible life of an adult lessee would ignore the personal element and be of doubtful validity.

A very perplexing matter was the rent to be charged. Any proper determination of the amount of rent or sale price for leaseholds and the time and manner of payment, must take into consideration the need for and use to be made of the money. Large expenditures are required to install the various public services and improvements necessary to make the shore land available for modern homes; and if these services, such as water, sewers, electricity, roadways, trails, parks and public lands in the environment of the home site, are to be maintained and further improved, the city must have a constant and dependable source of income available for such purpose throughout the term of the lease. This will cease to be a problem if the money is paid by those who are most interested and have a moral and just right to demand its expenditure for such maintenance and improvement. Springfield's plan, therefore, divides the price of the leasehold into two parts—one, payment into an improvement fund, by discounted single payment or early maturing installments, and the other, a continuing contribution to a maintenance fund. The form of lease adopted carries a plan of payment based upon the estimate that three-fourths of the price for the whole term will be required to

construct improvements. The remaining one-fourth of the sale price for the entire sixty years will be required to *maintain* public services, roadways, etc., and to police and care for the neighboring public lands. This part of the sale price is not subject to prepayment, but must run throughout the entire term. This arrangement is designed to insure high class care of the local improvements and neighboring public lands.

In preparing Springfield's form of lease, care has been taken to include such provisions as are desirable from the viewpoint of those lessees who wish to maintain the premises as attractive home sites. Accordingly, the lease contains many clauses not found in the restrictive covenants of real estate subdivisions, and gives the lessee substantial rights calculated to encourage the development of the area for permanent all year homes, and to maintain a high class neighborhood with a maximum of privacy. Thus, the lessee may exclude the general public, not only from the leased tract, but from the waters of the lake within 100 feet of the shore line, thereby insuring a fair measure of seclusion and giving the lessee, his family and guests, exclusive rights of bathing, boating and fishing along the lake frontage of the leased tract. This feature is enhanced by ordinances limiting the speed of boats, within 400 feet of the shore, to 5 miles per hour, thereby keeping the general boat traffic at a substantial distance. Peace and quiet of the neighborhood is insured by prohibiting the cutout and requiring under water exhaust or other adequate muffling device.

The shore land is divided into zones, different areas being allotted to all year homes and to summer cottages, with various gradations as to tract size and minimum dwelling cost, thus providing a fair measure of neighborhood uniformity. Other areas are set aside for public parks, bird and wild life sanctuaries, civic organizations, clubs, and other quasi public uses.

The legislative Act authorizing the leasing of the shore land also grants power to enact all ordinances, rules and regulations for the government and control of the artificial lake, the surrounding zone of land, and the protection of the same from pollution. To prepare ordinances adequately protecting the lake property as a source of public water supply and insuring the development and maintenance of the surrounding zone of land and improvements as a beautiful public park, requires not only much research and adaptation, but also considerable pioneering, on such subjects as sanitary control,

prevention of stream and lake pollution, regulation of boating, bathing and fishing, protection of bird and wild life, and promotion of forestation.

In following the path through the fields of the law on this subject, it will be generally found that the law, the courts, and those in positions of public responsibility appear to be sympathetic toward the efforts of the people to provide for themselves an adequate and pure water supply.

The most unique and interesting phase of Springfield's experiment is the acquiring by the City of the land surrounding the lake, adapting it to various recreational and other civic needs, and making use of parts as home sites for persons who not only improve, beautify and care for it at their own expense, but also protect the lake by acting as custodians of the public property. Truly, it is a noble adventure in cooperative community welfare.

It is sincerely hoped that Springfield's experience with the problems involved and the legal solutions achieved may be of benefit to other interested municipalities.

(*Presented before the Illinois Section meeting, April 10, 1935.*)

WATER WORKS RECORDS AND THEIR SIGNIFICANCE

By George B. Prindle

(*Superintendent, Water Works, Highland Park, Ill.*)

It has been said that a cardinal difference between civilized and uncivilized man is that the former keeps records. It is obvious that a social order which did not record the results of its activities would suffer from a handicap that would effectively hinder its progress. That we often fail to make proper use of historical data, is an indictment against ourselves, and not the records. Where social problems are involved, the ease with which we permit our emotions to sway our judgment is appalling. We not only insist that our lessons be learned by "trial and error," but each generation jealously reserves for itself the right to make its own trials and its own errors.

Fortunately those of us who are dealing with public water supply are working in the realm of material science. Here emotion plays a relatively small part, particularly in the interpretation of past performance. This, however, by no means excludes emotional enthusiasm as a spur to effort, for without it there would be none. The vision of great truths, and the will which through the ages has driven men to untold sacrifice for their establishment, are qualities which do not come from the head, but from the heart. Our great scientists have been more than great scientists—they have been great men.

The water plant operator may not consider himself a man of science, and yet he is putting into practical application the results of a vast amount of research in one of the most worth while and most fascinating branches of technical study. When we realize that, next to air, water is the most essential thing in our lives, it should stimulate pride in the work we are doing. Certainly the leaders of our profession have won for themselves a recognition in the world of science which should be a gratification to us all. But what of the rest of us—the rank and file, who are carrying on in a small way, and often against odds. It is comforting to remember that when great generals go forth to battle, they have a habit of taking a few privates with them. In fact we do not recall any great military victories which have been

won where this detail was overlooked. Therefore, we who make up the vast body of average plant operators may rest assured that we are most essential in the fight. Furthermore, the service we are rendering is indispensable to modern society. Without properly managed water supplies, sickness would cover the land, property would go up in flames, and there would be a deplorable absence of the traditional Saturday night tub. Under these circumstances we modestly admit that we *must* carry on, and this brings us to the subject of our records.

Probably there is no activity in a water plant a record of which might not conceivably be of interest at some later date. Unfortunately, we are limited in personnel, in time, and in energy. Therefore it behooves us to budget our efforts in this direction as carefully as we plan our financial transactions. To this end it seems logical to group these activities in the order of their importance.

SANITARY QUALITY

Except in rare instances, public water supplies are used for human consumption. Therefore the sanitary quality of the water becomes the first and most vital consideration. The operator is justified in sacrificing every other interest rather than supply his customers with a dangerous product. Being the activity first in importance, it is entitled to first consideration in the matter of records. It follows that every informative step in sanitary analysis should be recorded. This is essential both for the assistance it gives in plant operation and for the protection it gives the utility, should its output be unjustly criticized. We are all familiar with the type of fantastic criticism which sometimes springs from the vivid imagination of a customer who finding something amiss in his household immediately jumps to the conclusion, "There must be something wrong with the water." When such an emergency arises, the operator whose bacteriological records are what they should be, turns with confidence to his local and to his state board of health.

Just how voluminous sanitary analysis records should be will follow directly the amount of such laboratory work deemed necessary at the individual plant. Some operators who are handling water from a highly polluted source, and whose equipment is not of the most modern, must be content with an output which is always near the danger line. Here the simpler bacteriological routine, which will suffice in the more fortunate plants, will not be adequate. Realizing that he has but a small margin of safety, such an operator will

be justified in going to great lengths in sanitary analysis. And the records which he compiles will not only be a monument to the efficiency of his operation, under difficult conditions, but will constitute an unanswerable brief in favor of better equipment.

Physical and chemical tests which are relatively unimportant in some waters, take on great significance with others. Supplies which are subject to infrequent changes in turbidity—and to low maximums—do not require short interval observations, while other waters require constant watching, to prevent the overloading of filters. While we might in many cases be able to make a fair guess as to our coagulant needs, without measuring the turbidities, such a method could not be recommended. When it is remembered that the quality as well as the quantity of turbidity governs the treatment of muddy water, the value of individual plant records is evident. The experience of others may be valuable, but our own records should be more so.

Fortunately there is no way of guessing as to residual chlorine, and while there has been considerable academic discussion involving the laboratory routine of this determination, it is safe to say that the average operator does not go far wrong in his results. In the use of chlorine his primary considerations are, first, carrying a sufficient residual to insure a safe water, and, second, if possible keeping such residual below the point of objectionable chlorinous taste. If he can accomplish these objectives, he need have little concern as to whether the residuals he records represent the most accurate chemical findings.

As chlorine can be considered the most important tool in the purification of water supplies, its use deserves the most careful record. Former practice restricted its application to the filtered, or finished, water of a purification plant. In such instances, or where no other treatment is used but chlorination, it is obvious that a very heavy responsibility is placed upon this chemical. Then, to avoid the dangers of interrupted feed, frequent residual tests are imperative, and their record is as important, if not more so, than those of bacteriological analyses. The growing trend toward pre-chlorination of the raw supplies has added a tremendous factor of safety in plant operation, and while this has lessened the importance of frequent tests, the chlorine residual determination still furnishes the operator with the most immediate, and the most valuable information which comes from his laboratory, and deserves an important place in his records.

Just how essential the recording of the numerous other water tests

may be depends wholly upon their significance in plant operation. Some waters require extensive chemical determinations for their intelligent handling—particularly if softening is being practiced—while other raw supplies are of such character and unvarying quality as to render unnecessary all but the simpler chemical tests. Where extensive determinations are practiced their recording is seldom neglected.

TASTE AND ODOR

The newest development in water treatment, that of taste and odor control, has added another activity to our laboratories, and has furnished the operator with another yard stick for measuring the results of his work. As such control is relatively expensive, it becomes essential that it be efficiently guided. For this purpose Spaulding (1) has furnished us with a highly useful tool in his technique for quantitative odor determination. The records of such findings are important, as different waters vary widely in their response to treatment for odor removal. For most efficient results the operator must draw largely upon his own experience. With industry he will soon build up a history which will be most valuable in meeting new odor problems as they arise. In this connection the microscopic examination of water may prove useful in predicting odor epidemics due to increased growth of specific organisms, though the labor involved in such a daily routine would hardly be justified in any but the larger plants. Such examinations promise to be of more value in predicting short filter runs, as pointed out by Baylis and Gerstein (2). In Chicago's coming filter plants, where special treatment will be resorted to in times of severe organism trouble, the microscopic records will play an important part in daily control.

Assuming that the purification processes have been carefully guided, and the records pertaining thereto are ample and well preserved, there remain other phases of plant operation which should receive the operator's most thoughtful consideration. In a former paper (3) an effort was made to break down plant operating costs in such manner as to draw comparisons as to the financial importance of individual items. For this purpose a set of typical operating conditions was assumed, and cost data worked out therefrom. These figures were not intended as model cost data, but instead the *method* of comparison was emphasized. In that paper, we found that the

purification costs, with the assumed typical operating conditions, were but 12 percent of the whole operating costs, while other charges accounted for the remaining 88 percent.

ENGINEERING PHASES

It is then obvious that after having discharged his duty to the health of the community, by properly conditioning the water which he serves, the operator has a large further field for efficient plant management. Only by careful records is he able to justify the remaining 88 percent of his expenditures. A thoughtful compilation of the items will often point to subjects of fruitful investigation. For example, many an operator might find to his surprise that pumping machinery which he regards highly, because of its smooth operation and unfailing reliability, is in fact eating into the profits of his department because of its loss of initial efficiency, or obsolescence, or both. Too often the engineering phases of plant operation are neglected while intensive study is given to chemical treatment. Flaws in the former can easily waste more than the entire expenditure for the latter. Where electrical energy is purchased, the load factor becomes an important consideration under most contracts. The operator who is properly fortified with pumpage records, should be able to keep such factor at the highest point consistent with the limitations of his equipment and the variations of his water demand. Such records are also of great value in pointing out weaknesses in his plant, and enabling him to make replacements or additions before some emergency arises which he cannot meet.

In conclusion, there are endless plant records which might be kept. The individual operator must judge for himself those which will be most useful at his plant. He is to be cautioned against blindly copying another man's system. It may prove unsuited to his needs —in fact, it may have been unskillfully designed in the first place. Voluminous records, which have not been thoughtfully conceived, may be a tribute to our industry, but not to our intelligence. It is well to avoid making records manually which can be better and more accurately drawn by recording instruments. Too much effort in the collection of data robs us of the enthusiasm needed for their proper digestion. It is important that the original information should as soon as possible be entered in final form. It is most efficient that this be done currently, both to avoid errors likely to be made in

later wholesale transfer of records, and because of the wholesome feeling of well being which the operator enjoys who turns confidently to his files for immediate answer to the questions which may be asked him, instead of having to reply lamely, "We haven't figured that out yet."

(*Presented before the Illinois Section meeting, April 10, 1935.*)

REFERENCES

(1) SPAULDING, CHARLES H.: Some Quantitative Odor Determinations. Jour. Amer. W. W. Assoc., 24: 8, 1932, p. 1111.

(2) BAYLIS, JOHN R., AND GERSTEIN, H. H.: Microörganisms in Lake Michigan Water at Chicago. Municipal News & W. W., July, 1929, p. 292.

(3) PRINDLE, GEORGE B.: Perspective in Purification Expenditures. Jour. Amer. W. W. Assoc., 25: 7, 1933, p. 965.

REPORT OF A-21, SECTIONAL COMMITTEE ON SPECIFICATIONS FOR CAST IRON PIPE AND SPECIAL CASTINGS, YEAR 1934

TECHNICAL COMMITTEE 1—DIMENSIONS

Sub-Committee 1-A, Barrel of Pipe. In March a report was submitted by Professors M. L. Enger and W. M. Lansford on the tests on 48-inch pit cast pipe which they made for this committee at the University of Illinois. The tests included bursting tests on pipes 9 feet 7 inches long, full ring and quarter-ring flexure tests, Talbot strips, modified Izod impact tests, tension tests, Rockwell hardness and flexure tests on bars.

In March a preliminary Report No. 4 was submitted by W. J. Schlick, Drainage Engineer, on the tests of supporting strengths of 48-inch pit cast pipe which he made for this committee at Iowa State College. Four and 8 feet lengths were tested to destruction, some empty and the others under internal water pressures from 320 to 500 pounds per square inch, and all under external earth loads from 5 to 16 tons per linear foot.

At the meeting of the sub-committee in April, Prof. Enger reported on a series of tests which he had just finished for the committee at the University of Illinois on concentrated loads on 20-inch, Class B pit cast pipe, which confirmed his conviction that the bell is the strongest part of the pipe.

At the same meeting Mr. Schlick reported on a series of tests which he had just completed for the committee at Iowa State College on loads on 20- and 24-inch pit cast pipe on wood blocks, with and without wedges, and with both hard and soft wood.

As mentioned in the report of the preceding year, T. H. Wiggin, as Acting Chairman of Sub-Committee 1-A, submitted in March, 1933, tentative recommendations for thicknesses and pressure ratings for pit cast pipe, taking into account both water pressure and external load and based on all the tests made for the committee to that time, the largest pipe tested being 20-inch. Mr. Wiggin submitted a revised report under date of March, 1934, in which conclusions were

included from the tests on 48-inch pipes and the block tests above mentioned and this was followed by an addendum dated April 29, 1934. Meetings of the sub-committee were held in New York on April 4, May 7, May 8 and June 7, having available for these meetings the results of the new tests mentioned above on 20-, 24- and 48-inch pipe, and the reports above mentioned, together with supplementary recommendations.

After the June meeting study of these recommendations was continued the rest of the year by a group of the manufacturer members, with the assistance of Professors Enger and Schlick. Toward the close of December this group transmitted to Mr. Wiggin recommendations for thickness schedules of both pit cast pipe and special types of pipe, named in the producers' schedules as "Modern Weight" pipe, using the latter name to cover centrifugally cast iron pipe, bolted-joint cast iron pipe (Universal) and iron pipe cast horizontally in green sand with green sand core (McWane).

Sub-Committee 1-B, Bell and Spigot Dimensions of Cast Iron Pipe, Including Lugs and Harnesses. This sub-committee is preparing drawings showing the type of link harness used by the Board of Water Supply of the City of New York, where bell and spigot joints need such harness. Where it is known in advance that such joints are needed, the necessary rectangular shoulder can be cast on the spigot end. Sometimes there is an unforeseen need for such a joint and short steel clips may then be welded on the spigot end at the proper locations.

The sub-committee conducted a test to determine what shearing strength could be counted on, for the steel clips so welded on. For half of the specimens the welding, with Tobin bronze, was done by a commercial welding shop in New York and the other specimens were welded on, also with Tobin bronze, at the laboratory of the Linde Air Products Co. in Long Island City. Tests on all of these specimens were then made at Columbia University by Professor W. J. Krefeld in February, determining the force required to shear these steel clips from the cast iron pipe to which they had been welded. The shearing strengths developed were considered very satisfactory.

A memorandum on the Columbia test written in March by L. P. Wood, Chairman of Technical Committee 3, was adopted by letter ballot by the sub-committee as constituting the comments of the sub-committee on this test.

A meeting of the sub-committee was held in New York on April 4.

Sub-Committee 1-C, Types of Pipe other than Pit Cast. A schedule of tests desired on pipes other than pit cast had been adopted in 1933, but on account of the continuing business depression, none of the companies manufacturing these products made the scheduled tests except the American Cast Iron Pipe Company which had made similar tests previously.

Under the circumstances the Executive Committee determined to proceed with computation of schedules of thicknesses of special types of pipe, or pipe other than pit cast, using the best available information on the properties of each product and appointed a small special committee to guide this work. This computation work had been begun by Mr. Wiggin and assistant in May and a first draft of the schedules was completed in June, as described above under Sub-Committee 1-A. These computations were placed in the hands of the producers and studied by them in connection with schedules for pit cast pipe.

Sub-Committee 1-D, Fittings. Meetings of the sub-committee were held on March 6 in Philadelphia and on April 4, April 5, May 7 and June 7 in New York.

The sub-committee adopted by letter ballot the proposed short-body Class D standards for 12-inch and smaller bell and spigot fittings, and the revised Y-branch and 12-inch by 12-inch cross, recommended by the Cast Iron Pipe Research Association.

Studies of strength and proper pressure ratings of fittings by F. H. Stephenson, under the direction of T. H. Wiggin, the general chairman, were continued and resulted in a series of reports which were reviewed by the sub-committee at the several meetings. A "Groin Stress" method of analysis was used in the reports, a method not mathematically exact but an approximation involving much less computation than a rigid analysis. The reports presented the results of application of the "Groin Stress" method of analysis to the important standard fittings now used and those under consideration by the committee. During the last half of the year the manufacturers continued study of these reports and inaugurated a new series of tests on bursting strength of fittings supplementing tests previously made by the committee and by the manufacturers.

TECHNICAL COMMITTEE 2—METALLURGY, PROCESSES AND TESTS

Sub-Committee 2-C, Physical Tests and Test Specimens. The studies begun the preceding year by T. H. Wiggin and F. H. Stephen-

son on physical properties of test bars for fittings and pit cast pipes were presented in a memorandum by Mr. Wiggin in January, accompanied by a suggested specification for quality of iron and test bars.

A specification for ring tests and Talbot strip tests for pit cast pipes drafted by T. H. Wiggin was slightly revised and submitted by M. L. Enger, Chairman of Technical Committee 2.

The test bar specifications were rather drastically revised as to strength and deflection requirements by those attending the meetings of Sub-Committee 2-C on April 4 and the revised draft approved by Technical Committee 2 on April 5, in New York. The ring and Talbot strip test specifications were approved by both these committees.

TECHNICAL COMMITTEE 3—CORROSION AND PROTECTIVE COATINGS

Sub-Committee 3-A, Corrosion of Cast Iron. The Chairman of Technical Committee 3 has obtained the Report on Corrosion Investigations carried out at the Massachusetts Institute of Technology since the completion of the contract with this Sectional Committee, extending to about two years the tests on most of the cast iron pipe samples furnished by Sub-Committee 3-A. The results of this work done privately by M.I.T. are to be combined with the results of the tests made for the committee and which have been reported to Sub-Committee 3-A and it is expected to arrange for the publication of a comprehensive report on the entire investigation.

Sub-Committee 3-B, Organic Coatings. Tentative specifications for coal-tar dip coating for cast iron pipe and fittings were adopted by letter ballots of Sub-Committee 3-B in July and Technical Committee 3 in August.

Meetings of the sub-committee were held in New York on February 23 and April 4.

Sub-Committee 3-C, Inorganic Coatings. The amendment, for pipe sizes from 30- to 48-inch, to the tentative specification for cement mortar lining, was approved by letter ballots of Technical Committee 3 in May and the Sectional Committee in August.

An alternative specification, dated March 26, 1934, and entitled "Suggested Revision of Proposed American Tentative Standard on Cement-Mortar Lining for Cast-Iron Pipe and Fittings, dated July 20, 1931," was submitted by L. P. Wood acting on behalf of E. O. Sweet, chairman of the sub-committee, who was ill and after detailed discussion by correspondence with Mr. Sweet. A number of changes

in this alternate specification were made at the meetings of the subcommittee held on April 2 in Birmingham and on April 4, April 5 and June 6 in New York.

Much experimental work was done by the manufacturers to determine practicable numerical values for the limits and tolerances under the proposed specification, for sand, for water absorption of the finished lining, and for the effect of the lining on the water in the pipe. Under date of November 1, 1934, the manufacturers submitted a revised draft specification which, it was stated, was what they were prepared to accept.

Sub-Committee 3-E, Soil Corrosion. The paper on soil corrosion by K. H. Logan mentioned in the 1933 report of this committee was published in the March, 1935, Proceedings of the American Society of Civil Engineers.

DISCUSSION

EDWARD S. HOPKINS[1] AND GEORGE G. DOBLER:[2] Publication of excerpts (1, 2, 3) from the Braidech and Emery paper, relating to the spectrographic determination of elements in water supplies, has caused some question as to the potability of the Baltimore supply in relation to its lead content. This paper was presented before the Fifty-fourth Annual Convention of the American Water Works Association in June 1934. In it they state "The only sample to contain any appreciable amount of lead is that from Baltimore, which may contain up to 0.3 part per million as Pb."

A recent communication (February 11, 1935) from Mr. Braidech, has shown the original report to have been in error and that the value assigned should have been "Between 0.1 and 0.2 p.p.m. Pb. On checking further through our original notebooks, we found that the 0.3 p.p.m. figure was a stenographical error." Initially, not realizing the nature of the analysis to be made, the concentrated water was sent to Mr. Braidech in a glass vial closed with a lead foil wrapped cork. This specimen was filtered water as delivered by the plant, and it is believed some of the reported lead was obtained from the foil.

A second composite bi-hourly sample, of filtered water for the month of June 1934, was prepared and sent to Mr. Braidech last July. This tested by spectrographic analysis "an estimated lead content of 0.05 to 0.1 parts per million Pb." Storage of the composite sample was in pyrex glass bottles.

These results led to a careful lead survey of the entire water system as shown in the following table:

Analyses in Montebello Laboratory

Date Sampled 1935	*Location*	*Lead, p.p.m. Average*
Jan. 12	River Water	0.079
Jan. 14	Filtered Water. Effluent East Plant	0.022
Jan 17	Filtered Water, Effluent West Plant	0.017

[1] Principal Sanitary Chemist, Montebello Filters, Baltimore, Md.
[2] Senior Analytical Chemist, Montebello Filters, Baltimore, Md.

Date Sampled 1935	Location	Lead, p.p.m.	Average
Jan. 28	River Water, Filtered through Mandler Filter	0.013	
Jan. 29	Filtered Water, Effluent West Plant	0.008	0.015
Feb. 12	Tap, #17 Engine Co.—Low Service	0.008; 0.014	0.011
Feb. 13	Tap, #11 Engine Co.—Low Service	0.010; 0.009	0.010
Feb. 18	Tap, Pikesville Engine Co.—High Service	0.010; 0.010	0.010
Mar. 4	Tap, Laboratory—Middle Service	0.010; 0.009	0.010
Mar. 6	#36 Engine Company—Middle Service	0.008; 0.007	0.008
	Independent Analysis by City Health Department		
Feb. 6	Tap, 1624 Edmondson Ave. Middle Service	0.010	

The water in the low service area of the distribution system is supplied by gravity from the filter plant; in the middle service it is pumped to a distribution reservoir; in the high service it is repumped to a higher level reservoir. Five liter samples were used and the procedure for the determination was that found in Standard Methods (4). It was recognized that "In order to obtain accurate results, it is necessary to have the solutions under comparison possess the same general character. It must be remembered that the tint depends to a large extent on the size of the colloidal particles of lead, which in turn depend upon the nature of the salts in the solution and upon the way the solution has been prepared. Vigorous agitation, salts of the alkalies and alkaline earths, tend to coagulate the colloidal sulfide" (5). Extreme care was excercised to maintain standardized procedure while performing the determinations. The accuracy of the work is confirmed by the independent analysis of the Health Department personnel. This was undertaken in connection with another study and without knowledge of our work.

Commenting upon these results in comparison with those obtained by spectrographic analysis, it is to be noted that Braidech and Emery in their original paper state: "It is believed that this paper records a qualitative and a semi-quantitative analysis in which there is no contamination from blanks or reagents. . . . . Many text books contain tables showing the relative abundance of the elements in the earth's crest with respect to different regions. If sufficient data were available a . . . . table could be prepared showing the relative amounts of the various elements in surface and ground waters.

The data from this report are inadequate for such a purpose, both because it is a mere beginning and because it is only semi-quantitative." It appears reasonable and logical to conclude, therefore, that the excellent check results of the chemical determinations are to be accepted as more accurate than those of the spectrographic tests when placed upon a quantitative basis.

It is to be regretted that Powell (6) in the Edgar Marburg lecture before the American Society for Testing Materials in July 1934, accepted the spectrographic findings as definitely quantitative, commenting upon them as follows: "From a sanitary viewpoint, the presence of lead in such relatively large amounts in many cities' water supplies, especially Baltimore, demands more than passing interest." As shown by this discussion, the amount present is not in relatively large amounts and is not highly important from a sanitary viewpoint.

The presence of manganese is a seasonal occurrence in this supply (7). It is produced by the decomposition of plant life on the bottom of the deep raw water reservoirs, and is held in solution by a resultant high concentration of carbon dioxide (80 parts per million). To give assurance that such excessive amounts of carbon dioxide are not creating a soluble lead condition in the supply, monthly tests will be made upon a composite sample of raw and filtered water collected every two hours. This procedure will be continued for the present calendar year, although there are no known deposits of lead on the water shed.

REFERENCES

(1) Staff Report, Eng. News Rec., 112, 781, 1934.
(2) Staff Report, Water Works & Sewerage, 81, 255, 1934.
(3) Staff Report, Water Works Eng., 87, 718, 1934.
(4) Standard Methods for the Examination of Water & Sewage, p. 55, 7th ed., 1933. American Public Health Assoc., New York.
(5) Scott, W. W., Standard Methods of Chemical Analysis, p. 282, 4th ed., 1925, Van Nostrand, New York.
(6) Powell, S. T., Proc. Am. Soc. for Testing Materials, 34, II, 1934.
(7) Hopkins, E. S., & McCall, G. B., Ind. Eng. Chem., 24, 106, 1932.

LIST OF SECTION PAPERS

Fourth Short Course in Water Treatment, University of Florida and Florida Section Coöperating

West Palm Beach, Fla., March 27–30, 1935

Manufacture and Installation of Transite Pipe.....C. A. McGinnis
Boulder Dam Construction.....T. M. Lowe
Pipe Corrosion at West Palm Beach.....Keith R. Chinn
Fully Automatic Municipal Water Softening Plants.....S. B. Applebaum
The Case for Chlorine and Chloramines in the Control of Iron Bacteria
Charles H. Eastwood
Why Use B. Coli as a Pollution Indicator?.....Dr. Paul Eaton
Maintenance and Operating "Kinks" in Water Works and Sewage
F. E. Stuart
Cross Connections.....L. M. Fisher, T. M. Lowe and Louva G. Lenert
Water Resources of Florida.....A. P. Michaels
Organizing for Progress and Water Supply.....Harry E. Jordan
Some Water Supplies in the Tropics.....Dr. Henry Hansen
Licensing of Water Works Operators.....Louva G. Lenert
Most Probable Number Concepts in Water Bacteriology.....Dr. Paul Eaton
Recent Progress in Coagulation.....L. L. Hedgepeth
The Pumping of Water.....T. M. Lowe
Recent Advances in Water Treatment.....A. P. Black

Southeastern Section

Birmingham, Ala., April 2–4, 1935

Some Aspects of Interstate Carrier Water Supply Certification.....H. N. Old
Endeavors in Public Health Protection by Supervision of Water Supplies
Geo. H. Hazlehurst
Maintenance and Operating Kinks in Water Works and Sewerage
F. E. Stuart
Service to Municipalities Rendered by Underwriters' Organizations Maintained by Stock Fire Insurance Companies.....H. D. Cutter, Jr.
Business Administration of Waterworks.....W. E. Mathews
Elements of Sewage Treatment.....S. Vermilye
Shades Valley Sewage Plant.....H. H. Hendon

Illinois Section

Springfield, Ill., April 10–11, 1935

Legal Aspects of a Large Lake Water Supply Project.....Clayton J. Barber
The New Water Softening Plant at Woodstock, Illinois, and Cleaning Existing Water Mains.....J. A. Fulkman

Water Main Cleaning at Evansville, Indiana.....Charles Streithof
Assistance Given to Water Works Projects in Illinois by P. W. A.
C. M. Osborn
Address—Improving Water Works Practice.....Harry E. Jordan
Water Works Records and Their Significance.....George B. Prindle
Letting Your Light Shine.....Miller Hamilton
Some Unusual Possibilities for Pollution in Water Purification Plants
Clarence W. Klassen
Preparation and Conditioning of Aluminum Sulphate Solution before Applying to Water.....Carl Leipold
Filter Washing Experiments at the Chicago Experimental Filtration Plant
Herbert E. Hudson, Jr.
Recent Data on Chemical Quality of Ground Waters in Illinois
S. M. McClure
Water Well Specifications.....Milo A. Churchill
The Chicago Stock Yards Fire.....L. D. Gayton
Illinois League of Municipal Public Utility Employees...John W. Kerkering
Low Water Troubles.....W. R. Gelston
Aeration of Water by Air Diffusion.....Frank C. Roe

Montana Section

Helena, Mont., April 12–13, 1935

The Public Water Supplies of Helena, Montana.....J. E. Lupien
Water Works Construction in Montana Under the P.W.A. Program
D. A. McKinnon
Advantages of Filter Plants.....E. H. Dunmire
High Lights Along the Line of Progress in Water Works Development
W. P. Hughes
Water Tanks of Reinforced Concrete.....A. L. Hewett
The Well Program of the Montana Power Company at Missoula..H. S. Thane
The Glendive City Water Softening Plant.....C. W. Eyer
A Proposed Law for the Licensing of Water Works Operators
Dr. W. F. Cogswell
The Continuous Treatment of the South Fork Reservoir, Butte Water Supply, with Copper Sulphate.....M. W. Plummer
The Dead Man's Basin Water Conservation Project.....Fred Quinnell
The Municipality and Work Relief.....J. R. Cortese
Regulatory Measures Relative to Water Users.....C. J. Bausch
The Training of Water Works Operators.....W. M. Cobleigh

Pacific Northwest Section

Lewiston, Idaho, May 16–18, 1935

Water Supplies of Idaho.....W. V. Leonard
The Small Town Water System, Its Problems and Perplexities
M. H. McGuire

Chlorine Handling for Convenience and Safety.....Brian L. Shera
Waterworks Projects under the Public Works Administration
Ivan C. Crawford
Development of the Bremerton Water System.....Cliff Casad
Recent Improvements in the Seattle Water System .....Harold D. Fowler
The Lewiston System.....W. P. Hughes

ABSTRACTS OF WATER WORKS LITERATURE

FRANK HANNAN

Key: American Journal of Public Health, **12**: 1, 16, January, 1922. The figure 12 refers to the volume, 1 to the number of the issue, and 16 to the page of the journal.

The Oligodynamic Action of Silver in the Treatment of Water. J. GIBBARD. Can. Pub. Health J., **24**: 96–7, February, 1933. Results of experiments on exposure of water containing *B. coli* to silvered porcelain rings are summarized. Low temperature (8–10° compared with 22–5°C.) markedly retards oligodynamic action: presence of organic matter has similar effect. Silvered porcelain rings gradually lose their activity, but may be completely rejuvenated by treatment with dilute hydrochloric acid. Activity is definitely, although not greatly, less in light than in dark. At least 1 to 1.5 hours' exposure is necessary with new rings: under unfavorable conditions 24 hours may be required. Treated water has bactericidal properties. Concentration of silver in treated water increases with time of exposure, as follows: 1 hour, 0.03; 2 hours, 0.07; 3 hours, 0.15; 4 hours, 0.5 p.p.m. Method cannot be recommended for practical use at present time.—*R. E. Thompson.*

Developments in Water Supply and Treatment During the Past Year. NORMAN J. HOWARD. Cont. Rec. and Eng. Rev., **46**: 1442–7, 1932; **47**: 9–12, 1933. Comprehensive review of progress during 1932. At end of year there were 396 plants employing activated carbon for taste and odor removal.—*R. E. Thompson (Courtesy Chem. Abst.).*

The Past Year's Waterworks Activities in Ontario. A. E. BERRY. Cont. Rec. and Eng. Rev., **46**: 1448–51, 1932.—*R. E. Thompson (Courtesy Chem. Abst.).*

Cave-In Kills Five in Tunnel of Hetch Hetchy Water Project. Eng. News-Rec., **109**: 298, September 8, 1932. Cave-in during retimbering operations killed 5 men in Coast Range tunnel on August 28. Crew of 16 were replacing and strengthening timbering in completed section prior to concrete lining operations when roof and walls collapsed. Exact cause will probably never be known. Verdict of coroner's jury was "unavoidable accident."—*R. E. Thompson.*

Safety and Quality of Water Still Need Improvement. F. H. WARING. Eng. News-Rec., **109**: 341–3, 1932. General discussion of need of further effort in improving quality of water supplies. Quality is not always reflected in typhoid death rate: many corollary illnesses prevail in community with inferior

or only fair quality of drinking water. Conviction is growing that widespread illness prevalent under certain conditions, e.g., in areas afflicted by prolonged drought, is attributable in some way to the toxic effects of drinking water bacteriologically safe, but procured from highly polluted sources. Lime softening is most efficient single bacterial weapon in purification of badly polluted surface water.—*R. E. Thompson* (*Courtesy Chem. Abst.*).

San Jacinto Tunnel, Metropolitan Water District, California. Eng. News-Rec., 109: 766, December 22, 1932. Bids received on construction of 12.7-mile San Jacinto tunnel of Colorado River aqueduct are given. Low bid on entire job was $7,331,815. Separate bids were also received on east and west halves of tunnel. Tunnel is to be 16 feet in internal diameter, lined with concrete throughout. Contract was let on December 13.—*R. E. Thompson.*

Arizona Publishes a Code for Guidance in Building Dams. Eng. News-Rec., 109: 771–2, December 29, 1932. Regulations for design and construction of dams in Arizona, which have been issued in form of 30,000-word building code, are outlined.—*R. E. Thompson.*

Record-Size Cableway for Hoover Dam. Eng. News-Rec., 109: 408–10, October 6, 1932. Details given of cableway for Hoover dam, on which proposals have been received. Cableway, which will be capable of handling 150 tons, will be largest-capacity installation of kind in world. It will span Black Canyon, just below power house site, a distance of 1200 feet.—*R. E. Thompson.*

Development of Low-Heat Cement for Mass Concrete. R. W. CARLSON. Eng. News-Rec., 109: 461–3, 1932. Discussion of problem of heat generation in mass concrete and review of progress in development of low-heat cement. Reduction in proportion of $3CaO \cdot Al_2O_3$, by addition of Fe compound and by substantial increase in $2CaO \cdot SiO_2$, reduces temperature rise about 25 percent. Intergrinding of SiO_2, up to 50 percent, with cements used in construction of several dams substantially lowered the temperature rise and produced concrete of satisfactory strength.—*R. E. Thompson* (*Courtesy Chem. Abst.*).

Special Low-Heat Cement for Pine Canyon Dam. Eng. News-Rec., 109: 410–1, October 6, 1932. Cement prepared under specifications providing for material reduction in heat of hydration will be used in construction of dam on San Gabriel River, which will create main storage reservoir for water supply system of Pasadena, will be 325 feet above lowest point in foundation and 275 feet thick at base, and will contain 450,000 cubic yards of concrete. Structure will be of gravity design with straight crest, provision having been made for resistance to earthquake force with acceleration of 0.1 gravity. Specifications for special cement and procedure for determining heat of hydration of cement by heat-of-solution method are outlined.—*R. E. Thompson.*

New York City Not Permitted to Tap Underground Water. Eng. News-Rec., 109: 416, October 6, 1932. New York State water control commission, on September 30, ruled that New York City may not go into Nassau County to draw

additional 69 m.g.d. from underground supply of that section of Long Island. Governing point affecting decision is fact that commission cannot set time limit; grants must be in perpetuity. While there is ample water to supply present requirements, ultimately Nassau County will need all available water. Increased draft from underground sources was proposed to supplement supply before going to the Delaware.—*R. E. Thompson.*

Features of Control Equipment in Oshawa, Ont., Filtration Plant. E. DEAN WILKES. Cont. Rec. and Eng. Rev., **46**: 1036, 1932. Brief description of effluent rate controllers, wash water controller, and Omega Universal alum feed machine. Latter is controlled automatically by rate of flow through raw water Venturi meter.—*R. E. Thompson* (*Courtesy Chem. Abst.*).

New Filtration Plant for Shawinigan Falls. N. J. A. VERMETTE. Cont. Rec. and Eng. Rev., **46**: 1159–60, October 12, 1932. Brief description of electrical equipment of new 3-m.g.d. filtration plant at Shawinigan Falls, Quebec. Ultimate capacity will be 12 m.g.d. Pumps are electrically driven.—*R. E. Thompson.*

B. Coli in Spring Water Due to Salamanders. Eng. News-Rec., **109**: 373, September 29, 1932. Abstract of article in Natural History, **33**: 3, 303–10, 1932, entitled "Salamanders and Water Hygiene." Controlled laboratory experiments showed that 1 salamander excretes sufficient *B. coli* per day to contaminate 237 gallons of water heavily enough to be considered dangerous for human consumption. It is believed that salamanders act as reservoirs, or incubators, and, once infected with *B. coli* through feeding habits, continue to breed and excrete them. Autopsies showed marked increase in content both of food and of colon bacilli in stomach and intestinal tract during summer. Concluded that salamanders play important rôle in causing certain supplies to appear polluted.—*R. E. Thompson.*

Failure of Cable Kills Three Riding Bucket Down Water Shaft. Eng. News-Rec., **109**: 330, September 15, 1932. Failure on September 6 of cable supporting boom over 175-foot construction shaft to Larabee Street entrance to Chicago Ave. water tunnel precipitated to bottom of shaft bucket in which 9 workmen were descending. Three men were killed and others injured. Brief outline of conditions leading to accident given.—*R. E. Thompson.*

Unusual Features in Oshawa, Ont., Filtration Plant. FREDERICK A. DALLYN. Cont. Rec. and Eng. Rev., **46**: 1031–6, 1932. New rapid sand plant includes eight 0.75-m.g.d. units. Cost was $155,390.13, or $25,900 per m.g.d. When extension to full capacity planned for shall have been effected total cost should be less than $18,000 per m.g.d. Illustrated.—*R. E. Thompson* (*Courtesy Chem. Abst.*).

Etobicoke, Ont., Water Softening Plant. Can. Pub. Health J., **23**: 391, August, 1932. Contract has been let for installation of zeolite water softening plant, at approximate cost of $15,000, which will be first municipal softening

plant in province. Water was formerly secured from New Toronto. New well supply was found to contain 325 p.p.m. hardness and 1.4 p.p.m. iron. Plant will consist of 4 downward-flow units with total capacity of 1.5 m.g.d. It is planned to reduce hardness to 80 p.p.m. and iron to 0.3 p.p.m. Cost of treatment is estimated from 5 to 6 cents per 1000 gallons. Choice of method was governed by initial cost, operating cost, and ease of operation.—*R. E. Thompson.*

Sanitary Drinking Fountains. Can. Pub. Health J., **23**: 393, August, 1932. It is very doubtful whether some drinking fountains are more sanitary than common cup. Lips of drinkers should not come in contact with jet orifices. Observation of fountain users suggests following requirements as desirable: (1) jet of water should travel at angle rather than vertically: this prevents water from lips of user from falling back on orifice; (2) orifice should be protected by guard, to prevent contact with lips; (3) orifice should be so placed that stoppage of outlet will not permit waste water to reach and contaminate it.—*R. E. Thompson.*

Hoover Dam Cement Specifications Tentatively Formulated. JOHN L. SAVAGE. Eng. News-Rec., **109**: 558–60, 1932. Tentative specifications for cements to be employed in construction of Hoover Dam are given and discussed. In order to minimize volume changes and cracking, it is proposed to use two cements, of low and of moderate heat evolution, respectively. Former will be used during summer months and combinations of the two, blended at plant to be located in Boulder City, at other times, to meet field conditions obtaining. Effects of principal computed compounds in portland cement on strength and on heat generation are shown graphically.—*R. E. Thompson (Courtesy Chem. Abst.).*

Preparing for River Diversion at Hoover Dam. Eng. News-Rec., **109**: 622–4, November 24, 1932. Illustrated description of preparations for river diversion at Hoover dam site as of October 22. Actual diversion was subsequently begun on November 13 by blasting out arch cofferdams and rock barriers at upper portals of both tunnels on Arizona side.—*R. E. Thompson.*

Ten Articles on Hoover Dam Planning and Construction. Eng. News-Rec., **109**; 24, December 15, 1932. **From Colorado River Compact to the Closure of Black Canyon.** 701–5. Decade elapsed between signing of Colorado River compact and diversion of river at Hoover Dam site in Black Canyon on November 13, 1932. Events leading up to construction program are reviewed. Bibliography of major articles on project published in Engineering News-Record is included. **Bidding and Planning for the Construction Battle.** 705–8. Difficulties and risks involved are discussed and contractor's organization is outlined. **Huge Blast Turns River into Diversion Tunnels.** 708–9. Diversion of river on November 13 places construction program definitely 1 year ahead of schedule. **Permanent Cofferdams to be Large Earth-Rock Fills.** 709–11. Construction activity is now concentrated on permanent cofferdams which will complete diversion program. Two barriers sealing off dam site are

impressive structures in themselves. Upper one is 98 feet high and will contain 568,000 cubic yards of earthfill and 157,000 cubic yards of rock, upstream slope to be faced with concrete slab. Downstream cofferdam will be rolled earthfill structure, 60 feet high, protected on downstream side by rock barrier 53 feet high. **Colorado River Board Approves Design of Dam.** 711–2. Final approval of design of Hoover Dam was given November 19 by Colorado River Board. Few changes have been made since contract drawings were prepared. **Review of Preliminary Construction Operations.** 713–5. **Placing 300,000 Yards of Concrete Tunnel Lining.** 715–20. Details given of design of forms and of concreting procedure in lining 16,000-foot length of 56-foot diversion tunnels with 36-inch shell of concrete. Hugh bulk of concrete is equal to mass of many large dams. **Other Features of Project.** 720–3. Progress on construction operations other than tunnel lining and diversion programs is outlined. **Rapid Progress Revises Construction Schedule.** 723–4. Outline of future construction program. **Construction Guided by Extensive Research.** 724–7. Program of investigations and tests has already resulted in savings amounting to $2,170,000, many times cost of research work. Major studies are outlined. Pointed out that height of dam will be 732 feet, nearly twice that of Owyhee Dam, hitherto world's highest.—*R. E. Thompson.*

Thin Concrete Diaphragm Protects Ringedal Dam. CHR. F. GRÖNER. Eng. News-Rec., 109: 498–500, October 27, 1932. Disintegration of Ringedal dam, Hardanger, Norway, due to percolation through its porous masonry, has been effectively checked by construction of thin diaphragm of reinforced concrete parallel to, but independent from, upstream face of dam.—*R. E. Thompson.*

Current Dam Construction in Southern California. J. I. BALLARD. Eng. News-Rec., 109: 564–7, November 10, 1932. Outline of progress on Bouquet Canyon, Pine Canyon, and El Capitan dams of Los Angeles, Pasadena, and San Diego water supplies respectively, and on San Gabriel No. 2 dam of Los Angeles Flood Control District.—*R. E. Thompson.*

Relief Act Encourages Revision in Waterworks Policy. MALCOLM E. PIRNIE. Eng. News-Rec., 109: 336–9, September 22, 1932. "Self-liquidating" features of Emergency Relief and Construction Act of 1932 necessitate in most instances realignment of local government practice. Water service is worth more than its cost and there is sound economic justification for systems providing ample supply of pure water and adequate fire protection, and therefore for immediate construction of needed water works extensions. Political control may lead to insolvent operation and tax-secured bonds discourage self-supporting operation. Intelligent distinction must be drawn between public services rendered to real property and those rendered to individual. Cost of former must continue to be met from taxes on property, but costs of latter can be charged to beneficiary. Encouraging progress is indicated by two enabling acts passed by Indiana legislature authorizing cities and towns to establish sewage treatment works and water works on self-liquidating basis, enabling cities and towns owning water works systems to create department of water works to be entrusted with management and control of such systems and issue revenue bonds

payable solely from revenues. It is to be hoped that similar action will be taken in other states. Water works managements must be granted greater degree of autonomy and independence of action and assume corresponding responsibilities.—*R. E. Thompson.*

Changes in Financing to Follow Relief Act. E. B. BLACK. Eng. News-Rec., 109: 346–7, September 22, 1932. Emergency Relief and Construction Act of 1932 places great stress on proper financial management of municipally and privately owned water systems by requiring project to be self-liquidating in character to secure loan from Reconstruction Finance Corporation, and by defining self-liquidating project as one that will be self-supporting and financially solvent and able to return cost of construction within reasonable period through payment of tolls, fees, rents, or charges other than taxation. Further, projects requiring loan must comply with state laws and provisions of municipal charters for issuance of bonds. Where such laws or charters conflict with self-liquidating clause it appears that legislation or a freer interpretation of provisions of Act will be necessary to make projects eligible. Self-liquidating stipulation will mean general overhauling of rate structure of majority of publicly owned systems. Accounting practices to be followed will have to show in detail complete operating story of project. Water supplied to other city departments for fire protection, sewer flushing, street sprinkling, supply for public buildings, etc., not now directly charged to user, will have to be paid for in rates collected for such service; funds contributed to other city departments will have to be held under control of water department for its own use. Procedure to be followed in making applications for loans and data that must accompany such applications are outlined.—*R. E. Thompson.*

Most Waterworks Claimed to be Self-Supporting. Eng. News-Rec., 109: 506–7, October 27, 1932. Discussion by LEWIS E. AYERS of articles in September 22 issue of Engineering News-Record relative to Reconstruction Finance Corporation loans for water works construction and reply by MALCOLM PIRNIE. AYERS points out that municipal water works are more commonly "subsidizing" than "subsidized," when account is taken of water supplied free for municipal purposes and fire protection. PIRNIE states that he has found substantial number of municipal water works which require support from tax funds in excess of reasonable charges for public fire protection.—*R. E. Thompson.*

Water Works are Self-Supporting. CHARLES A. HASKINS. Eng. News-Rec., 109: 656, December 1, 1932. HASKINS believes that while some publicly-owned water works are partly subsidized by municipalities, reverse is true as general rule. In support of this belief, brief data are given regarding 21 of larger systems in Kansas relative to charges for fire protection, free water for city use, etc.—*R. E. Thompson.*

The Investor's View of Waterworks Bonds. Eng. News-Rec., 109: 347–8, September 22, 1932. Water company bonds, for technical market reasons, do not command as high a price as they deserve, but are much sought after by

well informed investors, especially insurance companies. Municipal water bonds are considered self-supporting and are favored over general municipal securities. Few defaults have been reported where payment is primarily dependent on water revenue. The school-district bond is only type of municipal security with better record in this respect. Although water bonds are considered self-supporting out of water revenue, in most cases general faith and credit of city is pledged as additional guarantee. Legally, usual water bond is merely a general obligation bond carrying provision that interest and sinking fund requirements are charge on water revenues. In event of default and subsequent judgment in favor of bondholders, bonds of this nature have no priority over other bonds. Bonds secured by water revenue only are uncommon, except where city's charter expressly authorizes it to operate as public utility. Bonds of this type carry trust indenture with sinking fund provisions and right of bond holders to have receiver appointed by court to operate property as public utility. Anomalous condition is apparent in water revenue bonds. Because of proved inability of holders of tax-secured bonds to realize on security by forced sale of property to satisfy delinquent taxes in time of depression, revenue bonds are really the better investment. Nevertheless average bond buyer continues to favor tax-secured bonds. Segregation of funds of water department from those of general municipal treasury is very desirable, but it is uncertain that water revenues can legally be made inviolate and safe from diversion for general municipal purposes without special provision for it. When surplus revenue of municipal water department which has been considered safe from diversion is taken for general city purposes in time of financial stress, effect is naturally highly injurious to water bonds. To prevent such occurrences it would be necessary for city government to provide that water revenues should constitute trust fund, to be deposited as such in local bank. Separate incorporation of water department, with ownership by municipality, might also solve question of diversion. Water company bonds made splendid record during recent slump in bond market.—*R. E. Thompson.*

Waterworks Planning for New Conditions. GEORGE W. FULLER. Eng. News-Rec., 109: 343–6, September 22, 1932. Rate of increase in population of country as whole is decreasing, and people are moving from center of cities to newer districts on outskirts and in suburbs. Data are given from recent census showing rapidity with which metropolitan areas are increasing in population. To meet these conditions, public water service, broadly considered, must be revamped in many important ways. Regional, or district, projects present many advantages. Water service ordinarily costs from $2 to $6 per capita per year or from 0.5 to 1.5 cent daily. Enormous strides have been made in improving economy of water service, but much still may be accomplished.—*R. E. Thompson.*

Supply and Distribution Facilities are Underdeveloped. G. GALE DIXON. Eng. News-Rec., 109: 339–41, September 22, 1932. Water supply improvements are desirable in nearly every city in United States. Supply works of highly permanent nature are most economically developed in units adequate for considerable periods, but owing to resistance encountered in advancing even meritorious projects they are seldom undertaken until neces-

sity is immediate and obvious. There probably is not a city in country in which distribution system improvements of at least minor nature are not desirable and necessary.—*R. E. Thompson.*

Portable Aggregate Plant for Hetch Hetchy Tunnel. H. V. EASTLING. Eng. News-Rec., 109: 654–6, December 1, 1932. Hetch Hetchy project of San Francisco is now complete, with exception of Coast Range tunnel, which will be 25.2 miles long, longest in world. Twenty-one miles has already been driven. Five shafts, two of them over 800 feet deep, were sunk and tunneling is being carried on from 12 working faces. Tunnel is 10.5 feet in diameter, concrete lined throughout. Lining will require 1,000,000 cubic yards of aggregate. Portable aggregate plant for this work is described and illustrated.—*R. E. Thompson.*

Dams on the San Andreas Fault. D. C. HENNY. Eng. News-Rec., 109: 385, September 29, 1932. HENNY points out that there were several shear cracks along plane of fault in Upper Crystal Springs earth dam after earthquake of 1906, and also numerous longitudinal cracks extending in either direction from fault cracks, both through top and slopes of dam. Structure at that time served solely as highway across one arm of reservoir, outlet conduit being open and water standing at same elevation on both sides of fill. There was difference of opinion regarding probable effect of quake if dam had been in operation as such. Only material which would have prevented actual crack along plane of movement is clean gravel, which would have subsided back into place, re-establishing contact. Such material placed in sufficient quantity downstream from core, well drained and reaching above water line, would to some extent insure against disaster in similar cases.—*R. E. Thompson.*

Beach Drainage Safeguards Alexander Dam. JOEL B. COX. Eng. News-Rec., 109: 466–9, October 20, 1932. Failure of Alexander Dam, earthfill structure of McBryde Sugar Co., is discussed and reconstruction is described. Immediate cause of collapse was local compacting of downstream beach section due to crushing of fragments (of laterite, disintegrated product of lava and volcanic ash). As result, permeability was rapidly reduced, allowing accumulation of hydrostatic head which finally blew out and precipitated slides. In reconstruction, drainage system was incorporated in beaches.—*R. E. Thompson.*

Accelerated Absorption Tests on Concrete. Eng. News-Rec., 109: 521, November 3, 1932. Brief outline of accelerated absorption test, employing standard compression cylinders, developed in United States Engineer Office, Rock Island, Illinois. After 7-day curing period, cylinders are weighed and oven-dried at about 240°F. for 24 hours. Cylinders are then weighed, cooled to room temperature, immersed in tank, and subjected to pressure of 200 pounds per square inch for 4 hours, after which they are reweighed and percentage weight increase calculated.—*R. E. Thompson.*

Removal of Iron and Manganese from Water. S. B. APPLEBAUM and M. E. BRETSCHGER. Ind. Eng. Chem., 26: 925–31, September 1934. Types of iron

and manganese removal plants are classified as follows: (1) aëration by various means followed by (*a*) filtration, (*b*) settling and filtration, (*c*) lime treatment, settling and filtration, or (*d*) as (*c*), but with special coagulants; (2) oxidation and filtration by manganese zeolite; (3) filtration through sodium zeolite without oxidation. Applications of each type are discussed and four installations are described. Manganese zeolite consists of sodium zeolite converted to manganous zeolite by manganous chloride and then oxidized by permanganate. On exhaustion it is regenerated by permanganate. Sodium zeolite of certain types will remove unoxidized iron and manganese while softening water and even after exhaustion for that purpose, since calcium zeolite is converted to ferrous and manganous zeolites. It is regenerated as usual with sodium chloride.—*Selma Gottlieb.*

Removal of Copper Sulfate from Water by Ferric Floc. C. J. BROCKMAN. Ind. Eng. Chem., **26**: 924, September 1934. Ferric floc removes copper ions from solution more effectively than alum floc, results for which were reported earlier, and pH range for removal is wider.—*Selma Gottlieb.*

Disposal of Refinery Waste Waters. W. B. HART. Ind. Eng. Chem., **26**: 965–7, September, 1934. Waste waters containing oil have been successfully treated in oil separators, as result of coöperative study sponsored by American Petroleum Institute. Emulsions are broken by heat, or by change in pH, followed by floc clarification. Studies on tastes and odors in public water supplies led to principle that waste waters should be so treated within refinery that after mixing with public waters they would not cause undue difficulty or expense in use of public waters by others. Most tastes and odors are due to organic sulfur compounds and phenols and usually come from waste caustic solutions, which are now being treated by various chemical methods. Refinery waste waters do not place a very great load on oxygen reserve of diluting waters. Most of recommended procedures have been applied at Philadelphia Refinery of Atlantic Refining Co. at an expense, during last four years, of about $500,000. In all cases results have been satisfactory.—*Selma Gottlieb.*

Electrometric Determination of Chlorides in the Ash and Sap of Plants and in Ground Waters. J. R. NELLER. Ind. Eng. Chem., Anal. Ed., **6**: 6, 426–8, 1934. Using the silver-silver chloride electrode, chloride values obtained on four ground waters were from 1.34 to 4.93 percent lower than the volumetric values. Electrometric method is preferable with low chloride concentrations, because of more sensitive end-point.—*Selma Gottlieb.*

Colorimetric Standards for Silica. H. W. SWANK and M. G. MELLON. Ind. Eng. Chem., Anal. Ed., **6**: 5, 348–50, 1934. Potassium chromate solutions suitably buffered, as with borax, gave best match in estimation of silica by molybdate method, as determined by visual and photo-electric colorimeters, Nessler tubes and a spectrophotometer. Picric acid and unbuffered potassium chromate standards were less satisfactory. Table is given of potassium chromate concentrations recommended. Either A. P. H. A. reagent, or an adaptation of that of DIÉNERT and WANDENBULCKE, is generally satisfactory for producing yellow color with silica.—*Selma Gottlieb.*

Colorimetric Determination of Silica in Boiler Water. M. C. SCHWARTZ. Ind. Eng. Chem., Anal. Ed., **6**: 5, 364–7, 1934. To avoid loss of silica in removing phosphate with calcium chloride in molybdate method, sample should first be buffered to pH 10 with sodium hydroxide-borate buffer. Maximum color is obtained by adding to 50 ml. of filtrate, 2 ml. of 10 percent ammonium molybdate solution followed immediately by 1 ml. of 3 to 2 hydrochloric acid solution. After 10 to 15 minutes, compare color with potassium chromate or picric acid standards.—*Selma Gottlieb.*

Spectral Determination of Fluorine in Water. A. W. PETREY. Ind. Eng. Chem. Anal. Ed., **6**: 5, 343–5, 1934. When a substance containing both fluorine and calcium is excited in electric arc or spark, band opectrum of calcium fluoride is obtained. Determination is made on ignited water residues by visual or photographic method. Standard plates representing known fluorine contents are used for comparison. *Selma Gottlieb.*

A Comparative Study of Certain Media Used in Presumptive Tests for Bact. Coli. M. P. HORWOOD and ARTHUR HEIFETZ. J. Bact., **28**: 199–211, August, 1934. Media studied were: (1) standard lactose broth, (2) SALLE'S crystal violet lactose broth, (3) DOMINICK and LAUTER'S lactose broth using erythrosin, brom cresol purple, and methylene blue, and (4) JORDAN'S brilliant green lactose peptone bile. In order of decreasing sensitivity for freshly isolated strains of fecal *Bact. coli* and for *Bact. aërogenes*, media ranked (1), (4), (3), and (2). For water samples tested, (1) was most sensitive presumptive test medium and (4) was almost as good; (3) gave highest percentage of positive completed tests and (4) gave almost as many. Superior results on presumptive test with (1) cannot necessarily be explained as false positive tests, but may be due to effect of the other media on certain *Bact. coli* strains. Authors believe (1) to be best presumptive test medium available and not to be abandoned without efforts to improve its effectiveness by buffering, shortening incubation period, and other means. They consider (4) also to be very valuable, but believe it should be studied further before being accepted as substitute for (1).—*Selma Gottlieb.*

Development of Water and Sewerage Systems in Kentucky. F. C. DUGAN. Bulletin of Department of Health, Kentucky, **7**: 4, 5, November, 1934. About $10,000,000 has been expended upon public water supplies and sewage disposal plants in Kentucky since beginning of 1929; 19 new public water supply systems have been provided, while practically all supplies then existing have been improved, or enlarged. Five years ago, 960,000 people were being served by public water supplies; present figure is about 1,280,000.—*G. C. Houser.*

Bridgeton's Water Supply Returned to Safe Condition. Public Health News (N. J. Dept. of Health), **18**: 8, 240, October, 1934. Cloudburst of August 2, 1934, caused flood at Bridgeton, N. J., and so damaged its water works system, especially pumping station and filtration plant, that it was necessary to resort to wells for an emergency supply barely sufficient for domestic requirements. As conditions at water filtration plant impaired purity of well supply, arrangements were made on August 4 to use water from tidal section of Cohansey

Creek, polluted with industrial wastes and sewage, which was passed through filtration plant and dosed so heavily with chlorine as not to be palatable. Following repairs, regular water supply was returned to safe condition on September 4.—*G. C. Houser.*

Well Water: Its Health Hazards and Safeguards. N. A. MERCER. Bulletin of State Board of Health of Kentucky, **7**: 3, 8, October, 1934. Well waters may be polluted by subsoil drainage, by defective well construction, or by carelessness in drawing or handling water. Most dangerous well is one in direct path of downhill flow of ground water from point of pollution. Protection from surface drainage should be adequate. Waste water must be conducted away from vicinity of well. Chlorinated lime offers cheapest and most practical method of sterilizing well water. Mortality and morbidity rates in rural communities from typhoid fever and other filth-borne diseases are now two or three times as high, on the average, as those obtaining in urban localities.—*G. C. Houser.*

Wisconsin Swimming Pool and Recreational Bathing Code. State Board of Health, Madison, Wis., 1932. Pursuant to authority granted it under Chap. 140 of 1931 Statutes and general public health laws, Wis. State Board of Health has enacted regulations covering sanitation, safety, and cleanliness of public bathing places and has approved certain recommended standards for their design, equipment, and operation. Standards, which deal with, among other items, chemical, physical, and bacterial quality of swimming pool waters, are those recommended by joint committee of Conference of State Sanitary Engineers and American Public Health Association.—*G. C. Houser.*

Water Supplies. L. G. LENERT. Health Notes (Florida State Board of Health), **26**: 6, 90, June, 1934. Driven wells are very common in many sections of Florida where water occurs at depths not exceeding 50 to 75 feet, and where little rock or other obstacles to driving are found. As a rule, good water is encountered at depths from 16 to 50 feet. Most driven wells in Florida consist of 1¼-inch galvanized pipe, fitted with special brass jacket drive point of suitable mesh (60 gauge).—*G. C. Houser.*

Water Supplies. L. G. LENERT. Health Notes (Florida State Board of Health), **26**: 7, 102, July, 1934. In Florida, drilled wells nearly always penetrate some limestone formations and there is little difficulty in obtaining water because of the many caverns and fissures; but it is often of questionable quality. Author outlines method of drilling, to prevent leakage of surface water into well, and methods of protecting springs from contamination by surface drainage.—*G. C. Houser.*

Scenic Highways and Unclean Streams. Health (N. H. State Board of Health), December, 1933. Resort interests are asking State of New Hampshire to construct 17-mile scenic highway to top the Presidential Range. Such construction would necessitate increased sanitary vigilance and, probably, further chlorination of public water supplies. Cleaning up of Ammo-

noosuc River, which traverses this same mountain territory, is work of at least equal importance. Detailed survey of conditions on this stream has shown gross and unwarrantable pollution.—*G. C. Houser.*

An Account of Relief Activities Following the Storm of August 22, 1933. Virginia Health Bulletin, **25**: 12, 20, December, 1933, violent storm swept Virginia, causing flood conditions in 13 counties. Drinking water problem immediately became acute in Gloucester county, where all wells were inundated and therefore unsafe. Supplies least affected were chlorinated. In Princess Anne county, people were advised to secure all drinking water from Virginia Beach. In York county, trucks were used to haul water from a safe supply, a 12-gallon can of which was placed daily before each home for a week, at end of which time the wells had been made safe.—*G. C. Houser.*

Sealing the Air Out; Not Keeping the Water In. Ohio Health News, **10**: 18, 3, September 15, 1934. Real aim of mine-sealing is to seal air out and thus check oxidation of undesirable mineral matter suspended in mine stream. "Works" are so constructed that water is the real seal. With oxygen supply cut off, oxidation ceases, sedimentation sets in, and issuing stream, free from suspended matter, is harmless. Up to September 1, campaign undertaken in Ohio by State and Federal governments had resulted in closing 1,500 mine openings at cost of $58,000. Number of mine openings remaining to be sealed was 16,000.—*G. C. Houser.*

In Time of Peace Prepare for War. Health News (N. Y. State Dept. of Health), **11**: 26, 102, June 25, 1934. Study of freezing of water mains, service pipes, and hydrants has been made by N. Y. State Department of Health by means of questionnaires sent to most of waterworks in State. Replies were received from 306, of which 147 reported frozen mains; 251, frozen service pipes; and 93, frozen hydrants; 181 municipalities reported a total of nearly 10,000 frozen services. Electrical thawing was most popular and in general most satisfactory method. Total of more than $125,000 was expended for thawing, exclusive of purchase of new equipment. Costs for thawing services averaged $8.50 but varied from $2 to $50.—*G. C. Houser.*

State Supervision of Small Public Water Supplies Discontinued. Public Health News (N. J. Dept. of Health), **17**: 10, 183, October 1933. Sources of water supplies for public potable purposes in New Jersey must be approved by State Department of Health. By resolution adopted December 6, 1932, department defined "public potable water supplies" as those from which water is distributed to consumers for potable purposes in eight or more dwellings or properties. Water from sources of supply distributed to less than eight dwellings will hereafter be considered as private sources of supply and under jurisdiction of local health board.—*G. C. Houser.*

Private Water Supplies. L. G. LENERT. Health Notes (Florida State Board of Health), **25**: 12, 170, December 1933.—Discussion of different types of wells and of precautions necessary to render them safe from contamination. —*G. C. Houser.*

Sanitary Districts for Unincorporated Communities Needing Waterworks and Sewerage Developments. Virginia Health Bulletin, **26**: 1, 14, January 1934.—Recent special session of legislature made it possible for unincorporated communities in any county in Virginia to form sanitary districts for development of waterworks and sewerage projects. District can issue bonds in amount not exceeding 18 percent of assessed value of all real estate in district. Vote must be taken in district to determine whether or not the majority of qualified voters favor the bond issue.—*G. C. Houser.*

Typhoid Fever Takes a Trimming. L. F. WARRICK. Wisconsin State Board of Health Bulletin, **5**: 18, 9, April–June, 1934. Typhoid fever failed to claim a life last year through agency of any public water supply in Wisconsin, but killed 17 persons who had contracted the disease from other sources. Private water supplies were believed responsible for most of these deaths, and although the 16 deaths from typhoid and one death from paratyphoid in 1933 marked new lows in Wisconsin annals, further public coöperation must be gained to put an end to use of unsafe wells and springs. For past five years Wisconsin has maintained perfect score in prevention of typhoid outbreaks caused by cross-connections.—*G. C. Houser.*

Records of Sewage Treatment Plant Operation Prove Their Worth. Health News (N. Y. State Dept. of Health), **11**: 30, 118, July 23, 1934.—At a county hospital, record is kept of sewage flow maintained at treatment plant. It was noted that flow for several days was 50 to 75 percent above normal. All water used at institution is pumped and treated in a modern filter plant. Investigation showed that automatic valve on ice-machine was permitting ½-inch stream of water to run to waste into sewer. Valve was repaired and sewage flow again became normal.—*G. C. Houser.*

Monthly Report, Bureau of Sanitary Engineering, Texas State Dept. of Health, September 1933. Regular work of bureau was disrupted after September 5, in order to give assistance to storm stricken area in Rio Grande Valley. **Sanitation Report of Work in the Rio Grande Valley, September 6–30, 1933.** PEARL KNAPE. 1. Emergency health problems growing out of disaster were: municipal water systems thrown out of commission; private water supplies contaminated; and menace of excreta-borne disease, due to contaminated drinking water. **Rio Grande Valley Report.** K. E. MILLER. 4. Every public water supply in Cameron County was impaired; the majority of them were rehabilitated with R.F.C. laborers. **Sanitation after the Hurricane.** R. C. GRAHAM. 8. Brownsville power plant, from which the power used to operate the pumps both for raw and for treated water is taken, was wrecked. Recourse was had to emergency pumping equipment. **General Report.** F. A. SCHRAMM. 9. Of 62 water samples bacteriologically examined, over two-thirds showed serious contamination before treatment. All, however, were clean after treatment with chlorine. **Report on Hidalgo County Relief Work.** L. H. MALE. 12. Following storm of September 5, practically all municipal water supplies in Hidalgo County were out of commission. By night of September 7, all water filtration plants were again functioning. Chlo-

rine dosage at each plant was stepped-up to sterilize distribution system.—*G. C. Houser.*

Drinking Water on Board of Merchantmen in the Tropics and Its Sanitary Appraisal. B. HYLKEMA. Archiv für Schiffs- und Tropenhygiene, Pathologie und Therapie exotischer Krankheiten, 38: 5, 183, Mai, 1934. The usual water supply carried in tanks in the double bottom, its purification by filtration through sand or carbon, its possible contamination by doubtful make-up in many tropical harbours, and excessive and avoidable pollution in charging the tanks are discussed. Danger due to infection persists in tropics, in spite of accelerated self-purification during early days after charging. After-growths in tanks result in enormous increase in protozoa; whereby the destruction of adventitious bacteria is intensified. Contamination during charging may be entirely eliminated, if known technical requirements are fully observed. In practice, however, entirely satisfactory conditions are seldom attained, so that, at least in the tropics, additional protection is necessary. Dangerous water in cooking galley might lead to food infection and for actual drinking water, sterilization is desirable. On shipboard, sterilization by heat is suitable. For sanitary appraisal of drinking water on shipboard, conditions during charging are the chief consideration, especially after water has been stored for several days at tropical temperature. Density of *B. coli commune is* applicable as bacteriological index only at first.—*Manz.*

Sanitary Appraisal of Chlorinated Swimming Pool Waters. (Zur Frage der hygienischen Beurteilung chlorierter Badewässer.) EDUARD REMY. Archiv für Hygiene und Bakteriologie, 112: 1, 14, April 1934. Repeated sampling, at times when most frequented, from the middle of the pool at depths from 1 to 2 meters, proved an even distribution of from 0.2 to 0.3 p.p.m. of chlorine residual, without offensive smell. After prolonged turn-over, increase in soluble matter, both inorganic and organic, is noticeable in pool water, but not always of phosphoric acid, total nitrogen content, or of potassium permanganate demand, tests characterizing in general the degree of pollution. Bacterial plate counts on gelatine, after removing liquefying colonies with potassium permanganate, were daily continued until no further increase could be enumerated. After 48 hours incubation, colonies were observed only when chlorine residual had dropped below 0.1 p.p.m.; but later, irrespective of chlorine residual and of bathing load, high counts were noticed. In no case, with 0.52 p.p.m. residual, did absolute sterilization take place. Chlorinated pool waters, which after up to 72 hours incubation show a pronounced poverty of germs, may thereafter develop a considerable growth, and not of spore forming bacteria only. Bacteria of the colon, typhoid, and paratyphoid groups are, however, killed with certainty. There is no reason to regard chlorinated pool water as a dilute disinfectant.—*Manz.*

Results of Chlorination of the Water Supply of the City of Bern, Switzerland. H. GUBELMANN. Schweiz. Verein von Gas- und Wasserfachmännern, Monatsbulletin 14: 2, 33, February 1934. Water from the old spring-district of the city was chlorinated to a residual of 0.10 to 0.12 p.p.m. down to 1925.

Later, chlorophenol taste appeared; origin of the phenol has not been cleared up, as neither phenol-containing industrial wastes, nor tar-paved roads, exist. It is believed that taste-producing matter derives from decaying leaves, or from dairy wastes. Musty taste was eliminated by treatment with 0.034 p.p.m. potassium permanganate; but this procedure had to be discontinued on account of staining of clothes. At last, by chloramin treatment, taste entirely disappeared. In connection with an inspection of the main reservoir, a biological examination was carried out; comparison with earlier results reveals that prolonged chlorination has exercised noticeable biological action by causing disappearance, or reduction, of certain species. Aftergrowths in samples were markedly diminished.—*Manz.*

Deacidification and Decarbonization of Water. A. EMUNDS. Schlägel und Eisen, **32**: 5, 93, 15 May 1934. Significance of lime-carbon-dioxide equilibrium for action of water on mains and use of marble test are discussed. Removal of excessive carbon dioxide by hydrated lime requires careful dosing, but raises temporary hardness by only half as much as filtration through marble. Deacidification by burned magnesite combines the advantages of the lime and the marble procedures, i.e., small increase in hardness and automatic dosage and is applicable also even with high temporary hardness. Since the equilibrium, as temperature increases, is displaced towards supersaturation, for cooling purposes, complete removal of carbonate is necessary, which in practice is effected by softening with lime. In order to reduce the detention period, intensive mixing is advisable. Lime dosage must be adjusted to the carbonate and carbon dioxide contents leaving out of account the magnesium hardness, in order to avoid the conversion of magnesium sulfate to calcium sulfate, which would cause deposits after concentration of the cooling water. According to new procedure of L. & C. Steinmüller, Gummersbach, water after application of lime is led at high velocity to small tank filled with contact bodies and then to settling tank with 30-minute detention period; at outlet of contact tank, reaction should be complete, purpose of settling tank being restricted to clarification.—*Manz.*

The Application of Activated Carbon for Water Purification in Breweries and Ice Factories. BRUNO MÜLLER. Der Apparatebau, **46**: 11, 109, May 25, 1934. Use of Hydraffin for de-oiling of condensate is discussed. Condensate is passed at rate of some mm. per second through 1-meter layer of specially prepared granular Hydraffin. Adsorption of oil is complete, accelerated by high temperature of condensate. When saturation of carbon is reached, renewal of carbon layer is necessary. In plant-scale test, with 3.5 p.p.m. oil in condensate, the Hydraffin took up 15 percent of its weight; thus 100 kg. Hydraffin took up 15 kg. oil, thereby de-oiling from 4000 to 5000 cubic meters (from 850,000 to 1,300,000 gallons) condensate.—*Manz.*

Dangers of Scale Removal by Acids and Their Prevention. A. SAUERMANN. Die Wärme, **57**: 22, 355, June 2, 1934. Removing, or loosening, of boiler scale by acid treatment is justified only where mechanical means, due to inaccessibility of certain parts of boiler, are impossible and main constituent of scale

is calcium carbonate. As deposits are never evenly distributed, attack of acid after solution of calcium carbonate proceeds on boiler plate, hydrogen and explosive oxyhydrogen gas being evolved. Acid becomes especially dangerous by penetrating into the laps of the joints, whereby the tightening action of riveting is lost and leakiness ensues. Use of pure acid is in all cases unsuitable. Acid treatment may be carried on in connection with an efficient protective colloid, followed by rinsing with alkaline solution and pressure tests at operating pressure. First application of acid treatment should be carried on only in coöperation with boiler inspection authorities, in order to avoid irreparable damage to the boiler.—*Manz.*

Determination of Sulfate in Waters Supplies and in Mineral Waters. OSKAR HACKL. Zeitschrift für analytische Chemie, 98: ½, 1–3, 1934. Practical experience in silicate rock analysis shows that preliminary precipitation of silica for gravimetric sulfate determination is unnecessary, if the cold dilute solution is acidified with dilute hydrochloric acid. Only with waters of very low silica content which have been greatly concentrated, is it advantageous to precipitate the silica: it is then important to treat the residue with enough hot water and acid to redissolve completely the precipitated calcium sulfate.—*Manz.*

An Apparatus for the Production of Re-Distilled Water. F. RAPPAPORT. Mikrochemie, 15: 2, 302, 1934. Description of glass apparatus for regular preparation of extremely pure water (of specific conductivity of 1.5×10^{-6}) from tap water distilled in air consisting essentially of two vessels, one inside the other, and cooling device. Steam generated by heating exterior vessel is led by a tube to interior vessel which is supplied through constant-level attachment with ordinary distilled water. Re-distillation thus takes place.—*Manz.*

High-Spring Water at Vienna and Lead Pipes. FRANZ X. MAYER. Abhandlungen aus dem Gesamtgebiet der Hygiene, 16: 1, 1934. Vienna water supply is derived essentially from two high-spring aqueducts; analyses show average total and carbonate hardness, 134 p.p.m.; chloride, 0,02 p.p.m.; nitrate, 2,5 p.p.m.; and sulfate, 12,0 p.p.m.; but no ammonia; pH is 7,9; supply contains 1,8 p.p.m. free carbon dioxide and is fully oxygen-saturated. As regards aggressivity towards lead, the water lies on the boundary line and exerts a slight, but noticeable, corrosive action. Samples taken from new pipes contain, sporadically, lead in excess of 1 p.p.m.; when drawn from same pipes 12 to 18 months later, after 14 hours standing, permissible limit of 0,3 p.p.m. is not exceeded. But even after approximately 25 years service, old pipe after prolonged contact will yield a measurable quantity. According to frequency of use, either a very thin greyish-brown coating, or a thicker yellow one, containing iron, calcium, and silica, is observed. In a comparative series of experiments with pipe of ordinary soft smelter lead and of two kinds of light-lead, respectively containing 0,25 percent cadmium and 0,5 percent antimony and 0,8 percent antimony, 0,3 percent tin, and 0,03 percent sodium, results indicated that there is no objection to the use of light-lead pipe of these compositions, as they do not increase the solubility of lead in local water.

No case of lead poisoning has been reported; but it is worthy of clinical investigation, whether the continued use for decades of drinking water with cited lead content can be considered as entirely harmless to arthritic individuals, etc. No solution of antimony took place. Tests on cadmium showed a solubility equivalent at first to 0,25 p.p.m., but decreasing after some weeks to negligible traces of 0,005 p.p.m. Sulfur-treated pipe is not recommended, as in samples from pipe drawn after 14 hours standing after several months in use, 0,1 p.p.m. of lead was found. There was no experimental indication that by earthing of radio sets to leaden water lines, any increased internal corrosion is caused.—*Manz.*

High Carbonate Hardness as Index of Ground Water Pollution. O. Lüning und E. Heinsen. Zeitschrift für Untersuchung der Lebensmittel, **67**: 6, 627, June 1934. According to the official statistics of the German municipalities, out of more than 1000 tap waters, only 9 are found with carbonate hardness over 357 p.p.m. In pure ground water a carbonate hardness over 357 p.p.m. is rarely, and over 446 p.p.m., never, observed. It is suggested that carbonate hardness in ground water, when excessive, as compared with that of corresponding neighbouring samples, may be considered as an index of pollution with organic matter, especially of such a kind as prevails in wastes, sewage, etc. Tests confirmed the fact that organic matter such as hippuric acid, glycocoll, or peat water, increases the solubility of calcium carbonate, thereby raising the carbonate hardness with corresponding increase in calcium content. This effect may be based upon reaction of weak acids, or colloids, to form calcium compounds which behave like calcium bicarbonate, being totally, or partially, titratable in presence of methylorange indicator. It was found that solvent action of organic matter percolating the subsoil with wastes is intensified by oxidizing influences, such as ferric-iron-bearing sand. Ammonium salts in concentrations of 200 p.p.m. cause an increased solubility equivalent to from 30 to 37 p.p.m. of calcium carbonate.—*Manz.*

A New Y-Shaped Fermentation Tube for the Examination of Bact. Coli in Waters. Filippo Neri. Zentralblatt für Bakteriologie/Parasitenkunde und Infektionskrankheiten, I. Abt. **132**: 7/8, 437, October 1934. Description of a fermentation tube consisting of a lower part 125 mm. high and of 15 mm. inside diameter, with a lateral inclined branch 90 mm. long and of 15 mm. inside diameter, and an upper narrower part 65 mm. long and of 9 mm. inside diameter for gas collection. The tubes are supported by a suitable double brass plate with holes and closed with glass tube.—*Manz.*

Determination of Sulfates in Boiler Water. Hellmut Reichelt. Chemiker-Ztg., **58**: 86, 871, October 1934. Report of investigations into the accuracy of rapid methods for this determination. When excess barium chloride is measured with chromate, due to the reducing action of organic matter, exceedingly low values, as low as 50 per cent of gravimetric result, may be obtained. As the interfering substances cannot easily be eliminated, methods using chromate are to be discarded. Owing, also, to the interference of organic

matter, in titrating excess barium salt with sulfuric acid, a sharp end-point with rhodizonate as indicator is not obtainable. For routine work, following modification of potassium palmitate method is recommended: 100 cc. boiler water are slightly acidified and freed from carbonic acid by bubbling air through for 10 minutes. Sufficient barium chloride is then added and after 10 minutes solution is neutralized and immediately titrated to the first appearance of color. The reagents are checked by running a blank. With potassium stearate, results obtained are less accurate. Time study indicated that test by palmitate method requires 85 minutes for completion.—*Mantz.*

A Water-Borne Typhoid-Fever Epidemic in the Black Forest. HEINRICH HORNUNG. Archiv für Hygiene, 113: 3, 158, December 1934. Epidemic, which occurred in May 1934, was due to fact that spring water supply of one hotel and of a youth-shelter was permanently more or less contaminated by wastes from another hotel higher up. Thirty-three persons who drank this water from various different taps developed typhoid fever after an incubationary period of 17 days and three of them died. Most of those infected and many others who did not contract the disease were attacked within 24 hours after drinking the polluted water with acute gastroenteritis, vomiting, and diarrhea. Those infected resided at 22 different places in the Black Forest. Due to the fact that independently of one another, the routes of the travellers crossed at a fixed place, it was possible to locate the source of the infection.—*Manz.*

Metabolic "Mutation" and Colonial Dissociation in the Genus Bacterium. IVAN C. HALL. J. Bact., 29: 1, 13, 1935. Common occurrence of metabolic "mutation" in genus *Bacterium*, frequency of *B. coli mutabile* (Massini) in intestinal tract of man, and complications due to *B. coli mutabile* in recognition of *B. paratyphosus* in feces, in food poisoning outbreaks, and in evaluation of potability of waters are emphasized. Ultimate criterion of lactose "mutation" is repeated isolation of rapid lactose fermenters from parent type perpetuating both itself and "mutant" indefinitely, but is usually preceded by slow fermentation of lactose and multiple papillae of secondary fermenting colonies on lactose agar media. "Mutant" rarely if ever reverts to parent type, and usually is indistinguishable from it morphologically, serologically, and culturally, except by its more rapid lactose fermentation and inability to form characteristic multiple papillae or secondary colonies. Simultaneous but independent occurrence of lactose mutation and colonial dissociation in *B. coli mutabile*, *B. cloacae*, *B. dysenteriae dispar*, and *B. dysenteriae* (Sonne) were found.—*Selma Gottlieb.*

Eosin Methylene Blue Smear Agar for Rapid Direct Count of E. coli. H. W. GEHM and H. HEUKELEKIAN. J. Bact., 29: 1, 28, 1935. Standard eosine methylene blue agar was used for direct count of *E. coli*. The various dilutions are smeared on hardened surface of medium, allowed to dry, and incubated for 24 hours before counting characteristic colonies. Good distribution was observed in all cases and very few other organisms developed. Counts ob-

tained in 24 hours were consistently higher than those by 48-hour brilliant green tube method but proportional thereto. Incubation for additional 24 hours gave few additional *E. coli* colonies on plates.—*Selma Gottlieb.*

A Critical Study of Some Media Used for the Detection of Colon Organisms in Water and Milk. C. N. Stark and L. R. Curtis. J. Bact., 29: 1, 27–8, 1935. Salle's crystal violet broth, Dominick and Lauter's broth, gentian violet broth, and brilliant green bile (2 percent) broth were studied. Crystal violet, methylene blue, gentian violet, and brilliant green were found to be growth-inhibiting. Bile was found to decrease toxic action of dyes and to accelerate growth of "false test organisms." Small numbers of colon organisms were able to initiate growth and produce gas in brilliant green bile broth, but not in crystal violet broth. Many bacteria responsible for "false tests" were able to grow in these media.—*Selma Gottlieb.*

Pitting of 18–8 in Two Naval Applications. Editorial, Metal Progress, Feb. 4, 1935. Rumors of serious failures of corrosion resisting steel in warships of U. S. Navy have been circulated and have disturbed many consumers of this metal. The 18–8 steel (18 percent chromium, 8 percent nickel) has given excellent service in deck houses, floors, hatch covers, and a variety of other structures exposed to atmospheric corrosion in port and to dashing spray or water in a seaway. It has also been satisfactory where the metal is attached to the hull so it is submerged almost continuously, such as rods and arms for operating diving fins on submarines and stranded wire cables for mooring. One failure was in gasoline stowage tanks containing variable quantities of gasoline, doped with tetra-ethyl lead and ethylene dibromide, and sea water more or less fouled with marine organisms or diluted sewage. The second unsatisfactory experience was with fire lines of thin-walled seamless tubing installed on the latest 10,000 ton cruisers. In both situations the stainless steel failed by pitting in as short a time as six months. Trouble by pitting apparently exists only in stagnant sea or harbor water, and there is not the least cause for worry about a multitude of applications in dozens of industries where chloride ions, stagnant solutions, and foul deposits are not encountered or not permitted. Very serious study has been given to these failures, both by naval personnel and various metallurgists. Some of the findings to date are discussed in the editorial.—*A. W. Blohm.*

The Importance of Proper Well Construction. A. H. Wieters. Southwest Water Works Jour., 16: 7, 14–16, 1934. Precaution on location and proper construction are stressed; cast iron casings are recommended. Regular bacterial tests should be made.—*O. M. Smith.*

The Water Softening Plant at Neodesha, Kansas. F. K. Vance. Southwest Water Works Jour., 16: 6, 11–12, 1934. Average cost of softening over period of two years has been about 1 cent per 1000 gallons. Itemized cost data and description of plant are given.—*O. M. Smith* (*Courtesy Chem. Abst.*).

Some Studies of Rapid Sand Filtration. GEO. F. GILKISON. Southwest Water Works Jour., **16**: 6, 21, 1934. A progress report.—*O. M. Smith* (*Courtesy Chem. Abst.*).

The Significance of Plankton in Kansas Waters. CASSANDRA RITTER. Southwest Water Works Jour., **16**: 6, 13–14, 1934. A short survey.—*O. M. Smith* (*Courtesy Chem. Abst.*).

Selection of Deep Well Pumping Equipment. R. E. SWANSON. Southwest Water Works Jour., **16**: 1, 9–11, 1934. In selecting pumps, length of service at unimpaired efficiency as well as original cost should be considered. Minimum and maximum values for various types of pumps are given.—*O. M. Smith.*

Modern Taste and Odor Control. F. E. STUART. Southwest Water Works Jour., **16**: 12, 19–22, 1934. Excellent survey of methods used.—*O. M. Smith* (*Courtesy Chem. Abst.*).

NEW BOOKS

A Laboratory Manual for the Chemical Analysis of Water and Sewage. E. F. ELDRIDGE and F. R. THEROUX. Lithoprinted by Edwards Brothers, Inc., Ann Arbor, Michigan. 1935. 5 x 8 inches. Cloth. 201 pp. $2.00 plus postage. The authors' desire to provide a "simple and concise laboratory manual of water and sewage chemical analysis" has been well fulfilled in this work. Quite elementary in its treatment of the chemistry involved, it will serve as a manual to those engaged in the operation of water and sewage treatment plants of small and medium capacities, as a convenient reference work to those more experienced, but who make infrequent use of laboratory methods, and as a text book in those schools whose courses include laboratory work of this kind. Section I, Methods of Analysis, includes 43 methods for water, 5 for reagents, treatment chemicals, and sand analysis, 27 for sewage, 6 for wet sludge, 7 for dry or processed sludge, 2 for sewage gas, and 9 for polluted waters. Section II, Reagents and Standard Solutions, covers the preparation of 107 items, each cross-referenced to the methods of Section I. Section III, Chemistry and Discussion of Methods, explains the fundamentals of chemical arithmetic, normalities, standard solutions, alkalinity, acidity, and pH, coagulation, water softening, special methods of mineral, chlorine, nitrogen, oxygen, and sludge analyses. The appendix includes notes on sampling methods, the use and care of laboratory equipment, plant records, atomic and molecular weights and conversion factors. The book is printed in typewriter typography which is well suited to a small volume of this nature involving many formulas and tables. This excellent little work should be valuable to those who feel the need of more fundamental information and interpretation of analytical methods than has been heretofore available in this form.—*R. L. McNamee.*

Report of the Water Analyst (Corporation of Madras) for the Year Ending 31st December, 1933. S. V. GANAPATI. 21 pp. In addition to the usual examinations made, results of which are given in extensive tables and figures, an investigation was inaugurated to determine the factors controlling the excessive content of organic matter of vegetable origin in the source of supply, Red Hills Lake, which is believed to be the cause of most of the difficulties attending slow sand filtration. Water supplied to the city was free of hydrogen sulfide and concomitant growths of sulfur bacteria for first time in many years. This was effected by aëration, sedimentation, rough filtration prior to slow sand filtration, reducing the 24- to 36-inch depth of fine sand in filters to 9 inches, operating filters at a semi-rapid rate (12 vertical inches per hour), and keeping close watch for first indication of hydrogen sulfide production, by means of lead acetate papers suspended in filtered water chambers. Absence of hydrogen sulfide permitted chlorination to be employed, average dosage being 0.72 p.p.m. Average daily consumption was 21.11 million gallons.—*R. E. Thompson.*

Proceedings

(Recorded for reference)

Selected Papers, Proceedings of the Third Annual Conference on Water Purification, Morgantown, W. Va., October 28–29, 1927. Technical Bulletin No. 1, Eng. Exp. Sta., W. Va. Univ., November 1927. **Establishing Classifications of Public Water Supplies of West Virginia.** E. S. TISDALE. 8–12. Public water supplies of State may be classified into three groups: good, doubtful, and bad. Eighty-two cities, 433, 408 people, have good supplies; 44 towns, 78,234 people, doubtful; and 28 towns, 47,001 people, bad, of which one town, 10,000 people, will be transferred to good class by construction now under way. **The Significance of the Colon Bacilli in Water.** R. S. SPRAY. 13–20. *B. coli* are easily cultivated, isolated, and identified and serve as index of sewage pollution. Distinction between *B. coli.* and *B. aërogenes* is somewhat difficult but may be effected by reactions on special media. **What Price Safe Drinking Water?** PERKINS BOYNTON. 21–30. It is no longer safe to use natural waters without purification. Artificial methods devised by man simulate natural purification processes. **Elimination and Recovery of Phenols from By-product Coke Oven Wastes.** HUGH E. JONES. 31–39. Recovery of ammonia from liquor condensed from raw coke oven gas releases a still waste of calcium phenolate, which, decomposed by carbon dioxide and other acids in the receiving water, liberates phenol. Phenol recovery plant using benzol extraction method treats 36,000 gallons of ammonia liquor per day and recovers more than 25,000 gallons of crude phenol per year (operating 12 days per month) with extraction efficiency of over 96 per cent. Design data and flow sheet given. **Tastes and Odors in Water Supplies with Special Reference to Waste Liquors from By-product Coke Plants.** W. W. HODGE. 40–54. Account of investigation of source of pollution of Morgantown water supply, which resulted in construction of phenol recovery plant noted above. **The Use of pH Control in a Sanitary Laboratory.** L. V. CARPENTER. 55–65. The practical application of pH in the control of coagulation of water. **Wa-**

ter Softening on a Large Scale by Zeolite Process. H. C. KNEELAND. 66–73. Ohio Valley Water Co. plant, McKees Rocks, Pa., of 4-m.g.d. capacity, cost $100,000. Operating cost, exclusive of overhead and supervision, is $20. per m.g. **Wheeling Filtration Plant. Operating Data and Costs.** G. E. RICKARD. 75–89. Description of plant processes, peculiar conditions of Ohio river water, and improvement in typhoid mortality. Cost of purification: in 1926, $5.99 per m.g.; in 1927, $5.12. **Improvements in Equipment and Technique of Operation of Chlorine Disinfection Apparatus.** R. C. CLEMENT. 90–92. **Grafton, W. Va., New Filtration Plant.** J. M. RICE. 93–96. Description of 3-m.g.d. plant and of zoning of pressures in distribution system.—*R. L. McNamee.*

Proceedings, Fifth Annual Meeting, Kentucky-Tennessee Section, American Water Works Association, Lexington, Kentucky, January 23, 24, 25, 1930. Mimeo. 8½ x 11 inches. 88 pp. **An Understanding Public.** W. C. STAIR. 6–12. Public confidence in a utility is essential to attraction of additional capital and to development of new business. **Discussion** points out importance of good public relations in selling water service. **Municipal Water Works Systems from the Public Fire Prevention Standpoint.** CLARENCE GOLDSMITH. 12–21. Civil service regulations for water department employees are desirable for successful long-term planning and continuity of policy. Accurate records of all elements of a water supply system are very necessary. A close coöperation between water and fire departments increases the efficiency of both services. Duplication of equipment and means for meeting various possible emergencies are important. Pumping station buildings and other essential structures should be of fire-resistive materials. Mains smaller than 6-inch should not be used for fire protection. Odd sizes, 10-, 14-, and 18-inch, should be avoided, as being difficult of repair. Direction of operation of valves should be uniform. Valve and hydrant inspections should be made regularly. **Design and Construction of Additional Filter Units.** A. T. CLARK. 21–27. Description and detailed design data of Lexington (Ky.) Water Co.'s new plant. Filter underdrain laterals are of cement-lined cast iron pipe with brass-bushed orifices. Filter washing is provided for by wash water at rate of rise of 16 inches per minute and air at rate of 4 cubic feet per square foot of filter at 4 pounds per square inch pressure. **Benefits Derived from Prechlorination.** J. J. QUINN. 27–33. Prechlorination at Knoxville during late months of 1929 eliminated septicity in settling basins, improved appearance of filter beds, lengthened filter runs, reduced wash water use, and increased bacterial removal. **Discussion** cited cases in which prechlorination had been found unsuccessful for reducing trouble from algae, but where use of artificial turbidity had benefited. **The Development of the Design and Operation of the Modern Filtration Plant.** C. B. BURDICK. 35–39. Forecast of future demand is essential basis for design of major improvements. Groundwaters are generally of limited volume and best suited to the supply of smaller towns. Surface waters generally require filtration. Storage is important, both for fire protection and for conservation of power. Water works construction can, and should be, made attractive. **Good Will and Its Importance.** J. C. MCCLENDON. 40–42. Sympathetic relations between public utility and public it serves are

essential to successful business. **Principles of Chlorination.** J. N. JERNIGAN. 43–46. Application of chlorine in water treatment is now being standardized and uniform results are more easily secured. **Factors in Cost of Water Mains.** Round table discussion of elements of cost of laying mains, including pipe, trenching, laying, repaving, etc. **Significance of the Coli-Aerogenes Group of Bacteria.** Dr. WM. LITTERER. 51–53. Simplified procedure for determination of coli-aerogenes gas-formers in water uses fermentation bottle fitted with a special top and special trays by which large number of samples can be incubated in fraction of space usually needed. Five samples can be examined in less time and at same cost as single sample by older procedure. Full description available on request to Division of Laboratories, Tennessee State Health Dept. **New Filtration Plant at Bowling Green, Kentucky.** D. E. DAVIS. 53–56. Description of new plant, including both low- and high-service pumping, chemical treatment, filtration and chlorination, including provision for softening, elevated tank and booster pumping station, and additions to distribution system, costing $299,424. **Water Supply and Its Relation to Disease.** Dr. J. L. JONES. 56–63. Surface waters should be purified before use. Ground waters may or may not be safe without treatment. Water is a vehicle for typhoid fever, dysentery, and cholera, though not the only means for transmission of these diseases. Education of the public concerning the value of safe water is needed. **Characteristics of Deep Well Waters in Tennessee.** W. F. POND. 64–69. The mountains of eastern Tennessee receive a heavy rainfall and there are many surface streams and springs. The population is small and there is no need for the development of deep well waters. The valley of eastern Tennessee also has a heavy rainfall and most of the large cities take supplies from surface streams. Farm and private wells are usually shallow, yielding moderately hard water, principally carbonate. In the Cumberland plateau, shallow wells yield soft waters; deep wells, hard waters, some containing sulfates. The well waters of central Tennessee are uncertain as to quantity and quality. Shallow well waters have non-carbonate hardness, 30 to 300 p.p.m.; deep well waters are very hard and contain much sulfate. In western Tennessee, most large towns take supplies from Wilcox formation (400–600 feet deep at Memphis), yielding a fairly soft water, but iron-bearing. **Algae and Their Control.** E. E. JACOBSON. 70–79. Since animal life feeds upon plant, or vegetable, portion of plankton, it is held in check by destruction of algae. Methods commonly used are, copper sulphate for large impounding reservoirs, chlorination for sedimentation basins and filtered water reservoirs, covering of storage reservoirs to exclude sunlight, excess alkalinity to remove food supply of organisms, and stocking reservoirs with fish to feed upon them. Most of trouble from tastes and odors due to algae can be avoided by early identification of organisms and application of appropriate treatment before water becomes heavily infested. **Leakage in Mains.** 80–81. Impromptu discussion discloses values of allowable leakage ranging from 80 to 250 gallons per inch diameter per mile [per day?—ABSTR.]. **Purification Plant of the Lexington Water Company.** M. E. FLENTJE. 81–88. Supply from watershed of 12.7 square miles, impounded in 5 reservoirs of 1765 m.g. total capacity, has been given copper sulphate treatment since 1905. Present plant includes two 1½-m.g. settling basins, and 10 wood-tub and two concrete filters, of 6.3 m.g.d. total capacity. Lack of washing facilities has

resulted in incrustation of sand in wood-tub units, and sand must be cleaned frequently by chemical treatment. New concrete units of modern type are provided with air wash. Tests have shown little change in effective size of sand in these units since their installation.—*R. L. McNamee.*

Report of the Third Missouri Water and Sewerage Conference, Sedalia, Missouri, October 13–15, 1927. 11 x 8½ inches. 116 pp. **Laboratory Control for Small Water Purification Plants.** C. E. HEFLIN and F. E. TURNER. 3 pp. Experience at Cameron, Mo., indicates value of bacterial analyses as check on treatment. **The Development of Filtration Plant Equipment during the Last Decade.** C. W. PAULETTE. 6 pp. Chlorination is now subject to dependable and accurate control. High-rate washing of filters is replacing air and low-rate wash. Dry chemical feeders have superseded solution tanks and orifice boxes. Rate controllers, gauges and operating tables have been improved in appearance and efficiency. **Common Sanitary Defects in Municipal Water Supplies.** H. D. PETERS. 8 pp. Bypasses, cross-connections, auxilliary intakes, inadequate sanitary protection of surface and underground water sources. **Notes on the Coagulation of Mississippi River Water.** E. E. WOLFE. 6 pp. Experiments with laboratory stirring device indicates optimum relations of paddle speed, detention period, alum dose, pH, color removal and turbidity reduction. **The Value of Publicity.** P. D. FIFE. 2 pp. Water as a product for sale should be advertised as are other products. **A Low Reading Turbidimeter.** A. V. GRAF. 2 pp. Description of device for determining turbidity by method of comparison with standard suspensions utilizing illumination at an angle. **Missouri Highway Sanitation.** S. O. VAN ACHEN. 5 pp. Specifications for grading of highway comfort stations. **The Relation of the Kansas State Board of Health to the Public Water Supplies of the State.** EARNEST BOYCE. 7 pp. Authority for, and procedure of, State Department in requiring minimum safeguards and recommending desirable improvements. **Pure Water as an Investment.** R. E. MCDONNELL. 4 pp. Pure water pays good returns in health, happiness, comfort, and wealth. **Fire Protection Features of Waterworks Systems.** B. SCHUERMANN. 12 pp. Discussion of the grading standards of the National Board of Fire Underwriters. **Essentials for Successful Operation and Maintenance of Small Water Purification Plants.** J. W. QUALLS. 2 pp. Adequate financing, compact and flexible plant design, and close watch of power costs are important. **Protection of Water Supply. Lakes and Reservoirs.** L. P. ANDREWS. 4 pp. Discussions of citizens' interest in, and right to use for recreational purposes, watersheds developed for water supply. **Certification of Interstate Carrier Water Supplies.** A. L. DOPMEYER. 6 pp. Administration of U. S. P. H. S. standards for purity of water supplies. **Modern Methods of Sewage Treatment.** E. J. MCCAUSTLAND. 4 pp. **The Economic Side of Sewage Disposal.** N. T. VEATCH, Jr. 5 pp. **Disposal of Sewage in Small Inland Towns.** T. L. WILEY. 2 pp. **Correcting Odor Nuisances at Sewage Plants by Chlorination.** L. H. ENSLOW. 10 pp. **Separate Sludge Digestion.** G. S. RUSSELL. 4 pp. **Development and Protection of Well Water Supplies.** H. S. MCQUEEN. 5 pp. Discussion of groundwater resources of Missouri and of proper means for development. **Economical Limitations of Well Pumping.** W. KIERSTED, Jr. 8 pp. Well casings, strainers, centrifugal pumps, deep-well turbine

pumps, plunger pumps, air-lift pumps. **Problems in Feeding Coagulation Chemicals.** E. E. HARPER. 5 pp. **When Should a Filter be Washed?** A. V. GRAF. 2 pp. **Round Table Discussions.** 4 pp. **Chlorination. Aëration. Growth of Filter Sand. Stream Pollution.**—*R. L. McNamee.*

Report of the Fifth Missouri Water and Sewerage Conference, Chillicothe, October 21–23, 1929. 6 x 9 inches. 87 pp. **Description of the Arrangement and Operation of the St. Joseph Water Purification Plant.** J. BUMBACHER, Jr. 6, 7. Plant using Missouri River water employs presedimentation, coagulation, settling, filtration (14.8 m.g.d.) and filtered water storage. **Home-made Filter Plant Appliances.** E. E. WOLFE. 8, 9. Filter loss-of-head and rate-of-flow, wash water tank depth, and reservoir elevation gauges. **Lime-Soda Ash Softening of Municipal Water Supplies.** J. G. HACK. 10–16. Discussion of functions and processes of softening and of difficulties to be avoided. **Discussion.** Popular favor for softening is increasing. Average person suspecting ill effects of softening, cannot distinguish softened from unsoftened water. **Office Problems in Water Works Operation.** K. N. WELLS. 17–21. Collection of slow accounts, adjustment of unusually large bills, and building up of favorable public relations require careful attention. **St. Louis' New Howard Bend Water Works.** J. D. FLEMING. 22–27. Reasons for selection of site, and general description of 55-m.g.d. plant, with details of basins for settling and carbonating highly turbid Missouri River Water. **Developments in Water Softening and Water Purification.** C. P. HOOVER. 28–33. Advances made in chlorination, taste and odor elimination, filter washing, corrosion correction, removal of rust from pipe systems, removal and return of sludge, recarbonation, and iron removal by zeolite. **Sanitary Water Analysis.** R. L. LAYBOURN. 34–37. Technique and significance of bacterial analyses, and proper methods of sampling. **Discussion.** Points out value of plant laboratory in relieving state laboratory of routine tests. **Discussion of Tastes and Odors in Surface Water Supplies.** G. F. GILKINSON. 38. Taste and odors are due to natural stream purification or to the failure of this process, to industrial wastes, or to artificial influences in water purification process. **Sewage Treatment in Missouri.** W. S. JOHNSON. 39–43. **Production and Collection of Sewage Gas.** G. S. RUSSELL. 44, 45. **Sewer Rental Charges.** N. T. VEATCH, Jr. 46–54. **Records and Tests for Sewage Treatment Plants.** H. M. BOSCH. 55–59. **Progress made in Sewage Treatment.** C. K. MATHEWS. 60–64. **Development of Ground Water Supplies.** R. O. JOSLYN. 64–71. Preliminary investigation is an important step which should not be omitted. Type of well should be suited to geological conditions, size of plant, and other factors. Discussion of well pumping equipment is limited to vertical turbines. **Water Supplies in Southeast Missouri.** A. C. MAGILL. 72–76. Deep wells in limestone, lead mines, Ozark streams and springs, shallow wells in alluvium, and the Mississippi River are developed for municipal supplies. **Distribution Problems.** E. C. M. BURKHART. 77–78. Steps taken in modernizing water system of small city. **An Application of Geology to Deep Well Water Supplies.** H. S. MCQUEEN. 79–81. Cites case at Mansfield, Mo., where geological investigation discovered rock faults that accounted for failure of existing wells and led to location of successful new wells. **List of Members.** 82.—*R. L. McNamee.*